Sorensen Full Line Catalog

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SORENSEN
POWER SUPPLIES

RAYTHEON

Sorensen Power Supplies

Full Line Catalog

SORENSEN Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

RAYTHEON

Sorensen Company

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History

Founded in 1943 to develop and produce specialty transformers and 400 Hz regulators for airborne use, Sorensen was the first commercial firm to manufacture and market precision electronic voltage regulators and power supplies.

Development of the basic Sorensen regulating circuitry for 60 Hz ac voltage regulators logically led to the design of related devices. This simple, reliable control circuitry was first adapted for a line of low-voltage, high-current dc power supplies. As engineering experience broadened and deepened, a line of high-voltage, low-current B-supplies was developed. With this framework of basic ac and dc supplies established, the company continued its pattern of research, development, diversification and expansion. A profusion of diversified, but related, products followed. Military and commercial inverters and frequency changers (variable frequency power sources), tubeless magnetic amplifier-controlled dc power supplies and ac line voltage regulators, transistorized converters, inverters, and ac to dc power supplies, a broad line of high-voltage equipment — all contributing to and substantiating the complete Sorensen line.

In 1959 Raytheon Company acquired Sorensen. In 1970 all manufacturing facilities were moved from Norwalk, Connecticut to a 160,000 sq. ft. plant in Manchester, New Hampshire. In addition there is a 40,000 sq. ft. shipping warehouse in nearby Londonderry, New Hampshire.

Over the years, Sorensen has supplemented standard product lines with custom developments to satisfy unique regulating problems, such as those inherent in large, complex computer systems and in stringent military applications. In these areas, Sorensen has been a pioneer and a continuing leader in the application of new components and manufacturing techniques. The company has acquired substantial experience with the most sophisticated semiconductors, printed circuitry, miniaturization problems, encapsulation, and high temperature techniques.

Capabilities

Today, all phases of electronic and semiconductor art are applied in achieving optimum performance and maximum life in Sorensen-engineered equipment.

This diversity of engineering approach and capability enables the company to channel its aggregate ability and experience according to the customer's needs. The product line consists of several series and many models of power supply units. The series range from laboratory and industrial power supplies to digital-to-analog interface units and modular switching power supplies.

Facilities

Complete facilities are maintained for manufacturing and finishing transformers, chokes, and reactors. A fully equipped finishing department routinely satisfies rigid commercial requirements.

Elaborate test facilities provide thorough testing of components and completed units. All electrical, mechanical, physical and environmental tests are performed on the premises.

As an entirely separate function, on a management level with engineering, production, finance and marketing, the quality assurance department implements a comprehensive program, beginning with the earliest design stage and following through to the final assurance of customer satisfaction. This total quality assurance concept is actually maintained by four major activities: (1) new design control, to review engineering specifications on each new or redesigned catalog product; (2) incoming material control, employing the most thorough quality control methods; (3) product control, to maintain superior quality levels in the manufacturing areas; (4) customer service, to maximize product satisfaction.

Controlled Process Meets Requirements of MIL-1-45208A Inspection Systems

MIL-1-45208 is a specification which established the inspections and tests necessary to substantiate product conformance to drawings, performance specifications, and contractual requirements.

Sorensen products are manufactured in a controlled process which meets the requirements of MIL-1-45208A inspection systems. With the increasing purchasing possibilities in the defense industry, this may be a factor you can use to advantage in marketing your products which contain Sorensen power supplies.

Complete Engineering Assistance

Although Sorensen offers a comprehensive line of standard "off the shelf" power sources, the engineering department is always pleased to discuss special power supply problems, fully integrated power systems, or modifications to standard units for special requirements.

Sorensen Catalog
Contents

Pages

Sorensen Power Supply Engineering Information 1-15

Glossary of Terms 16

Warranty 17

MODULAR POWER SUPPLIES SECTION

SSD Series, High Power, Switching Power Supplies 18-21
STM Series, High Efficiency, Switching Power Supplies 22-25
SLC-B Series, Dual ac Input, Switching Power Supplies 26-29
SRX Series, High Power Density (2.47 W per cu. in.), Switching Power Supply 30-33
PTM Series, Single and Dual Output, Linear Power Supplies 34-37
QSA Series, Wide Range Adjustable Output, Linear Power Supplies 38-41
NM, KM, LM, PC Board Mounting, Miniature Encapsulated Linear Power Supplies 42-44
DM, DL Series, Chassis Mounting, Miniature Encapsulated Linear Power Supplies 45

POWER ASSEMBLIES SECTION

Features and Options 46-47
Selection Chart/Specifications, Single Output Series (SSD, STM, PTM, SLC-B) 48-49
Selection Chart/Specifications, Dual and Wide Range Adjustable Output (PTM and QSA) 50
Standard Rack Sizes 51
System 319, (3.5″ x 19″ x 19.4″) with various front panel options 52
System 519, (5.25″ x 19″ x 19.4″) with various front panel options 53-54
System 522, (5.25″ x 19″ x 22.4″) with various front panel options 55-56
Accessories 57
Rack Sub-Assemblies 58-59

POWER INSTRUMENTS SECTION

SRL Series, Medium Power, Variable Programming Laboratory and Industrial Power Supplies 60-63
DCRB Series, High Power, Single Phase Input Laboratory and Industrial Power Supplies 64-69
DCRA Series, High Power, Three Phase Input Laboratory and Industrial Power Supplies 70-76
DCRA Series, Optional Equipment (ST101, RP9 Kit, CSE Kit) 77
QRD Series, Bench, Lab, Test and System High Speed Programmable Power Supplies 78-80
QRD Series Rack Mounting Accessories and Optional Equipment 81
OVP Models Overvoltage Protectors for QSA and QRD Series 82-83
ACR Series, Solid State ac Line Regulator 84-87
ACR 500 Series, Rack Mounting Adapter, RP7 85

DIGITAL-TO-ANALOG PROGRAMMERS SECTION

488 DAP Series, Two Channel, Programmer, Interfaces to GPIB Bus per IEEE/488 88-91
RA500 Series Power Assembly (488 DAP) 91

General Ordering Information 92

Power Supply Information Request Form 94
Sales & Service Representatives 95-100

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Introduction

The term "power supply" may, depending upon one's discipline, have a very specific meaning. For example, to an astronaut, a power supply is a fuel cell. Automotive engineers may consider a storage battery as a power supply. Power-distribution engineers may think of a turbine/generator combination as a power supply. Indeed the definitions of "power supply" are as many and varied as the number and types of disciplines in which they are used.

However, to laboratory workers, computer and system designers, original-equipment manufacturers, and many others "power supply" has a singular definition: it is an electronic device that accepts an electrical input and conditions it to a usable form.

Included within the broad framework of this definition are ac-to-ac converters and dc-to-dc inverters. These notwithstanding, however, the most common electronic power supply is the ac-to-dc supply, the simplest form of which is the unregulated supply (Figure 1).

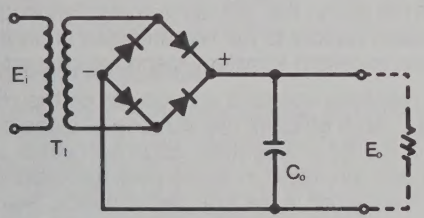


Figure 1. Unregulated Power Supply

Quite obviously, an unregulated supply has very limited capabilities and therefore limited uses. Chief among its drawbacks is its reaction to load changes: both the output current and voltage will assume new values for a change in load level. Clearly, this is in most cases unacceptable. What is normally required for many loads is a constant voltage, independent of current changes. Or, in other words, a supply that

exhibits zero output impedance, $\frac{\Delta E}{\Delta I} = \frac{0}{i} = 0$

This is, in essence, what is meant by ideal regulation.

As would be expected, ideal regulation is not practically achievable except by expensive compensation techniques. Attempts at obtaining a constant voltage independent of line and load changes have been and continue to be quite numerous. Many were developed and applied by Sorensen in the years since 1943. However, through a process of distillation, optimization and reliance on experience, coupled with a willingness to adopt technological advances, four basic types of supply may presently be found in Sorensen's broad line. These are: series-pass, series-pass with preregulation, high-frequency switching (HFS), and phase control.

Series Pass

The simplest yet usually most effective regulation technique for low-power requirements is series pass. Implementation of this technique involves comparison of the output with a fixed reference. The comparison errors which develop are differentially amplified, and the resultant signals are fed back to an error-sensitive, dissipative control element. This control element absorbs the difference between the "raw" output of the unregulated supply and the voltage across the load. Figure 2 illustrates the basic series-pass configuration. Note that the unregulated supply of Figure 1 is simply appended by the control element (power transistor) and the comparison network. Note too that the output voltage, although regulated, is fixed since there is no means of adjustment. Control may be achieved quite simply by changing R_3 from a fixed resistor to one that is variable. A supply with this modification and in the configuration illustrated is known as a "slot" supply inasmuch as the output voltage adjustment is restricted to a narrow range or slot. The presence of a shunt-connected, zener-type regulating diode precludes control to zero, i.e., the minimum voltage of the slot supply must be at least the reverse breakdown voltage of the zener.

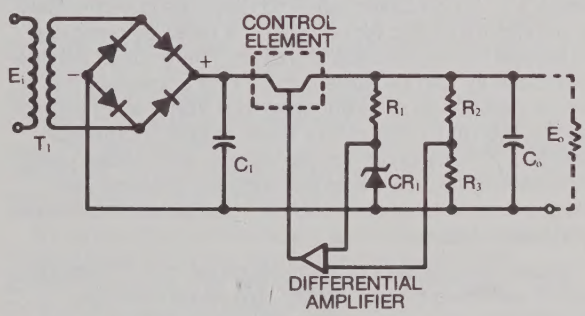


Figure 2. Basic Series-Pass Configuration - Constant Voltage

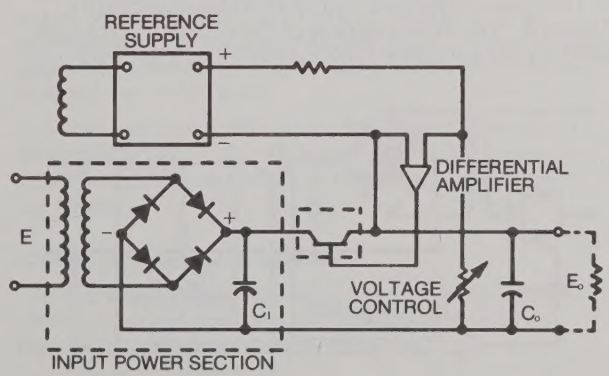


Figure 3. Series-Pass Ranger - Constant Voltage

The "slot" supply finds wide usage among original-equipment manufacturers. The PTM, QSA, MM and CM series are all "slot" type power supplies. However, laboratory and system users find the inability to control to zero unacceptable. To obtain control down to zero, the reference is usually made independent of the output by utilizing a fixed, highly regulated negative source as shown in Figure 3. This is the basic configuration of all Sorensen series-pass "Rangers" such as QRD and QRL series. The reference supply itself is a series-pass type which is very similar to the fixed-voltage supply of Figure 2.

This then completes the discussion of the series-pass technique as it applies to constant-voltage supplies. Further additions to the basic circuit yield overcurrent, overvoltage and current-regulating features. These will come under consideration in later sections.

Series Pass with Preregulation

As mentioned previously, the series-pass regulator is an excellent performer in low-power applications. However, it becomes less and less practical as attempts are made to design power supplies with higher output power (>200 watts.) It should be evident that, depending upon load requirements, the passing stage will not be called upon to dissipate continuously at maximum rating. Nonetheless, it must be designed to handle the worst-case situation. The unused dissipative capacity can be quite large if one considers that a single pass stage is rarely used, but that a technique of paralleling up to a dozen or more stages is common practice. Extension of the paralleling techniques yields diminishing returns since the supply's physical size must increase to accommodate more power transistors and heat sinks.

Stated simply the problem becomes one of maintaining or reducing power supply size while simultaneously increasing power-handling capabilities. As a solution, Sorensen selected a preregulated series pass design for its high-performance SRL "Ranger" series.

The basic schematic configuration is depicted in Figure 4. The preregulator is of the phase-control type utilizing back-to-back Silicon Controlled Rectifiers (SCR's) on the input transformer's primary. The preregulator serves to maintain the pass-stage voltage at a low constant magnitude. Hence, pass-stage dissipation is the product of the load current and the regulated Vc-e rather than a function of the output voltage as is the case in the simple series-pass regulator. In essence, the preregulator varies the input-transformer secondary voltage in response to manually or remotely programmed output voltage changes and, to some degree, to line and load changes.

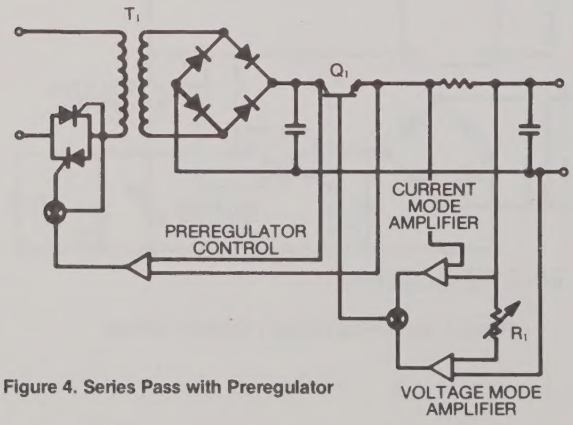


Figure 4. Series Pass with Preregulator

As an example of preregulator operation, assume that potentiometer R_1, Figure 4 is adjusted to produce a lower output voltage. The voltage-mode control section, in response to programmed change, drives Q_1 toward cut-off. The preregulator amplifier senses the voltage across the pass stage and responds by delaying the SCR firing signal. Delayed firing reduces the secondary voltage at T_1, and, consequently, pass-stage Vc-e, the difference between the secondary and output voltages, is maintained at a constant level.

The preregulator functions in a similar fashion to provide line and load regulation. The series-pass stage, in addition to giving the SRL its fine regulation characteristic, reacts rapidly to full line and load changes to produce an excellent transient-response characteristic.

With a relatively constant voltage across the series-pass stage, more efficient use is made of stage capacity, and hence the preregulator approach yields a four or five-to-one reduction in series-pass transistors. The results are reflected in the fine performance, high power, and low volume characteristics of the SRL (see Power Instruments section for a complete listing of SRL specifications).

High Frequency Switching (HFS) Regulation

In an era that has seen quantum reductions in the size of electronic devices, commercial power supplies have shown little inclination to follow industry trends. In addition, being basically dissipative regulators, they waste enormous amounts of energy in the form of heat. Sorensen, recognizes the theoretical limitations in conventional regulators, has advanced the art through the development of high-frequency switching (HFS) regulation techniques. the results of its efforts is the SRX line. A basic functional block diagram is illustrated in Figure 5.

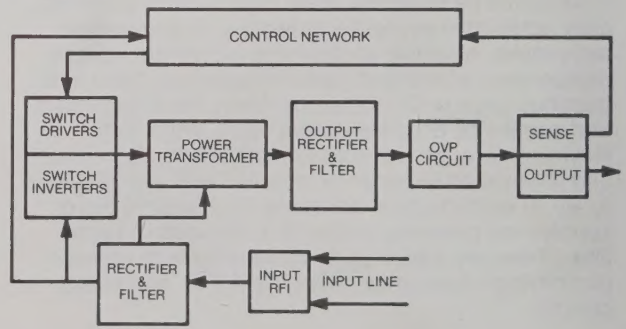


Figure 5. Basic HFS System Operation

In the SRX, the ac line is filtered, rectified, and then inverted at a 20-kHz rate. Inverter output is transformed down, rectified, and filtered to produce a dc output. Regulation is achieved through a feedback network which modulates the inverter duty cycle in response to output-voltage perturbations.

Due to the use of high-frequency switching techniques, magnetic and capacitive components within the SRX are physically much smaller than those utilized in conventional regulators. In addition, the switches are basically non-dissipative, being either fully conductive or nonconductive. Hence, the efficiency realized far exceeds that of conventional devices. The result is a small power supply with, on a watt-per-watt basis, less heat loss. The combination of smaller size, higher efficiency and little premium in cost makes the SRX an attractive alternate to series-pass "slot" supplies. The SSD, STM, SLT and SLC series use similar 20kHz techniques.

The high frequency switching generates noise spikes which appear on the output. These spikes exceed the normal ripple (typically 20 - 100mV spikes are present) and must be considered in critical applications.

Phase-Control Regulation

The series-pass with preregulation technique yields a power supply that can be applied to medium-power loads, provides fine regulation, is economical both from the standpoint of initial cost and cost of operation, and is compact. However, like its companion technique, series pass, it too becomes impractical when applied to high-power supplies. In addition, many of its operating characteristics are overqualified for the commonly encountered high-power loads, i.e., the buyer pays for characteristics which are not required.

To handle high-power loads, Sorensen developed phase-control regulation and produced its popular line of DCR supplies. With phase control, no dissipation elements are used but a form of switching similar to the preregulator principle is applied. Just as in the case of the SRL series, a pair of silicon-controlled rectifiers are employed for each input phase.

The SCR is a device well suited for power-supply applications. It can pass high currents, block high voltage and is controllable by external signal. When forward biased, it acts as an open circuit until a signal is applied to its "gate." It then switches rapidly into a conductive state and remains "on" until either the forward bias is removed or reverse bias is applied.

Sorensen made full use of these characteristics by employing a pair of back-to-back SCR's on the primary side of the input transformer (Figure 6). The input voltage alternately forward and reverse biases one SCR and then the other. By utilizing a suitable triggering or "gate" signal network the SCR's pass a modulated or "chopped" portion of the input voltage. This voltage is transformed, rectified, filtered and then applied to the output terminals.

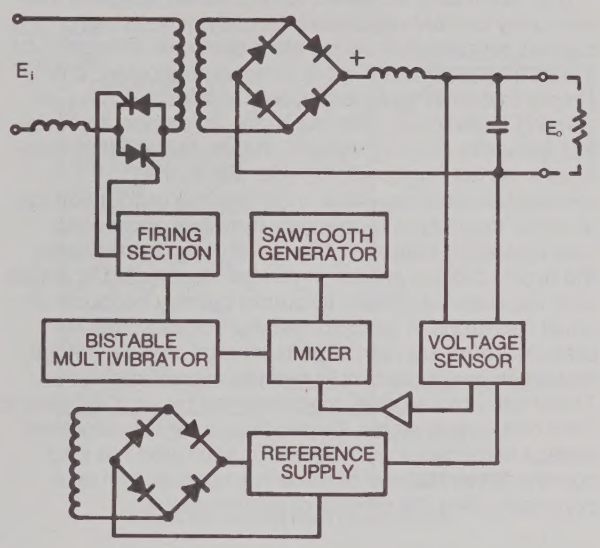


Figure 6. Typical Phase-Control Configuration

A typical triggering circuit employed by Sorensen is illustrated quasi-schematically in Figure 6. A portion of the output voltage is compared to a fixed reference, and any error signals which develop are differentially amplified and then mixed with a sawtooth signal. The combination of sawtooth and varying dc level is applied to a bistable multivibrator which switches "on" and "off" as a function of the dc level. The multivibrator when "on" inhibits a relaxation oscillator whose pulse-train output is used in SCR firing.

By expanding on this basic technique and utilizing three-phase networks, Sorensen has made 1000-ampere supplies that are available "off-the-shelf." See DCR-A and DCR-B series.

It should be noted that, although the phase-control technique yields a relatively inexpensive, high-power highly efficient supply, it does have some concomitant drawbacks. Its response time is in milliseconds as compared to the microsecond response of series-pass supplies (commutation is limited to twice the line frequency, i.e., 1/120 sec.)

Series pass may offer a regulation characteristic 10 times better than that of a phase-controlled supply, i.e., 0.005% vs 0.05% as well as much lower ripple (1mV vs 100mV).

Constant-Current Techniques

If the ideal voltage regulator has zero output impedance, the ideal constant-current regulator should have an infinite output impedance, i.e.,

$\frac{\Delta E}{\Delta I} = \frac{e}{o} = \infty$ Like voltage regulation, this is

not a practically achievable goal although 0.02% I_o current regulators form part of almost every standard-product line.

It is rare today, however, to find power supplies that are solely current regulators. Usually, a constant-current supply will incorporate a constant-voltage mode. The rationale for this is not complicated. It is simply that both types differ only in their output-sensing techniques, with the input, reference and control networks all but identical. In fact, the sensing techniques do not vary considerably. While the constant-voltage regulator monitors the output voltage at either the output terminal or remotely at the load (see operating features), the current regulator senses the drop across a precision resistor connected in series with the load. Variations in output current produce small variations in sensing resistor voltage drop. In essence, there are twin circuits, one to provide voltage regulation and a second to provide current regulation. These two error signals are combined by an "OR" gate to yield one output signal. Depending upon the reference voltage settings for each amplifier and upon the load current demands, one of these twin circuits will take command. See the crossover section below.

Crossover Point

An important consideration in selecting any bi-modal supply is evaluating the supply's performance as either its output current in the voltage mode or its output voltage in the current mode approach the crossover point, i.e., that point at which the supply switches from one regulating mode to the other. Ideally, the crossover "knee" should have a right-angle characteristic as shown in Figure 7. A sharp "knee" is desirable inasmuch as it indicates continuous regulation through the crossover region.

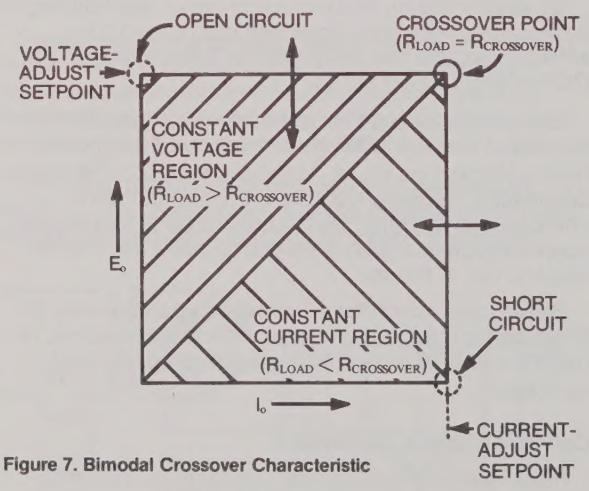


Figure 7. Bimodal Crossover Characteristic

Rounded "knees" indicate loss of regulation before the current (or voltage) reaches its crossover value. It should be noted that very sharp knees are a practical reality and are common in dissipation-type supplies.

To help in interpreting Figure 7, an example is offered: assume that a constant-voltage supply is operating at no load. This corresponds to the "open circuit" point. If a small load is applied and then is slowly increased, I_o would increase until $\frac{E_o}{I_o} = R_{crossover}$. At this point, the supply converts to the constant-current mode. If the load continues to increase, the short-circuit point will be reached with the corresponding requirement that $E_o = 0$.

As may be deduced from Figure 7, bimodal supplies have built-in current or voltage-limiting features. Figure 7 should be compared to the current limiting characteristics of Figure 10 and 12.

Protection Circuits

The need for output protection in power supplies is evident. Near short-circuit conditions can draw currents high enough to destroy the supply; an overvoltage condition, on the other hand, may destroy the load. Two types of protection then are needed: overvoltage and overcurrent.

Overvoltage

Inasmuch as all output-voltage regulation techniques utilize sensing and error amplification in their feedback loops, it is not surprising that a component failure within the loop can drive the output voltage many times higher than its preset value.

With voltage-sensitive loads such as integrated circuits, an overvoltage condition could produce a catastrophic failure, with its consequent loss of time, money and material. Redundant circuits and the use of "hi-rel" components offer only a partial solution. Although component-failure prevention is a goal of any design, the most effective method of protecting voltage-sensitive loads is to inhibit the output voltage as it begins its excursion outside the regulation band. A typical circuit used by Sorensen to effect overvoltage protection is illustrated in Figure 8. If E_o begins to

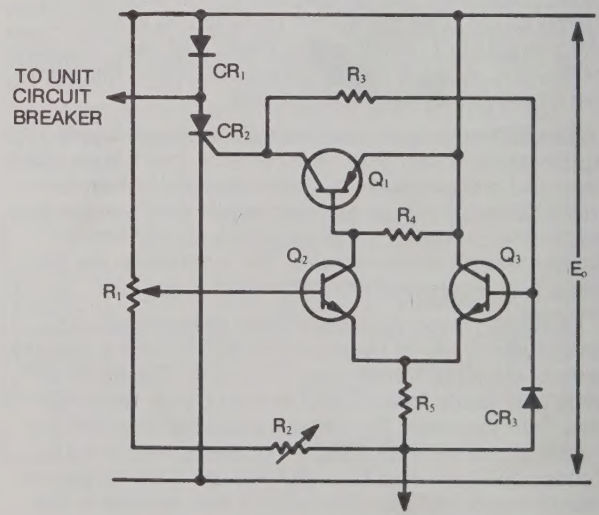


Figure 8. Typical Overvoltage Protection Circuit

increase rapidly, as in an overvoltage condition, the voltage across R_1 increases driving Q_2 further into conduction. As a result, the voltage drop across R_4 increases, and drives Q_1 into conduction, the resultant current pulse, "gates" CR_2 on, and the output is effectively shorted, decreasing E_o to a voltage equal to the forward drops of CR_1 and CR_2. The unit circuit breaker may be connected to the network as indicated. This assures that the supply will shut down automatically and will remain disabled until positive, corrective action is taken. Overvoltage circuits can be made to operate rapidly. For example, the circuit in Figure 8 has less than a 10-microsecond response time.

Overcurrent

There are three basic types of overload or short-circuit protection circuits employed by Sorensen. One, already discussed under *Crossover Point*, is simply a fringe benefit derived from owning a constant-voltage/constant-current supply. The other two, current limit and current feedback, are utilized in modular supplies where compactness is desirable and where a constant voltage is the only requirement.

A typical current limit circuit is illustrated in Figure 9. The voltage drop across R_4, caused by the load current, determines the drop across R_2 ($V_{R2} = V_{R4} - Q_1 V_{be}$). If V_{R4} and therefore V_{R2} become sufficiently large, Q_1 conducts and the error signals applied to the control element are inhibited as a function of load current. A typical characteristic is shown in Figure 10.

The current-foldback circuit is similar to the current limit; however, its "knee" is more rounded, i.e., there is poorer voltage regulation as the output current approaches the foldback setting.

A typical foldback circuit is shown schematically in Figure 11. Note that divider, R_1 and R_2 is connected across the output terminals. Under normal conditions $V_{R3} < V_{R1}$. However, if the load current rises to approximately 125% of I max rated, then $V_{R3} > V_{R1}$, and Q_1 conducts to inhibit the control-element drive network. A typical foldback characteristic is illustrated in Figure 12.

The advantage of foldback limiting is that the power dissipated in the series pass element is greatly reduced at short circuit. This action prevents overheating under short circuit conditions.

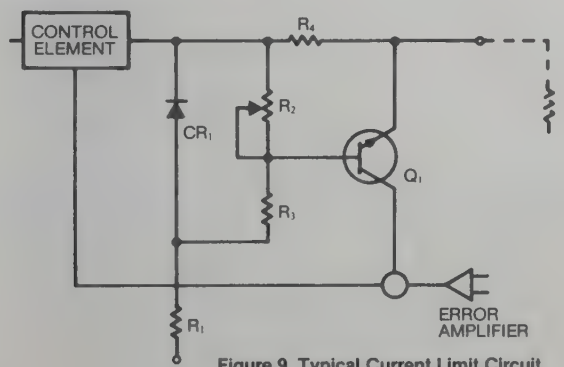


Figure 9. Typical Current Limit Circuit

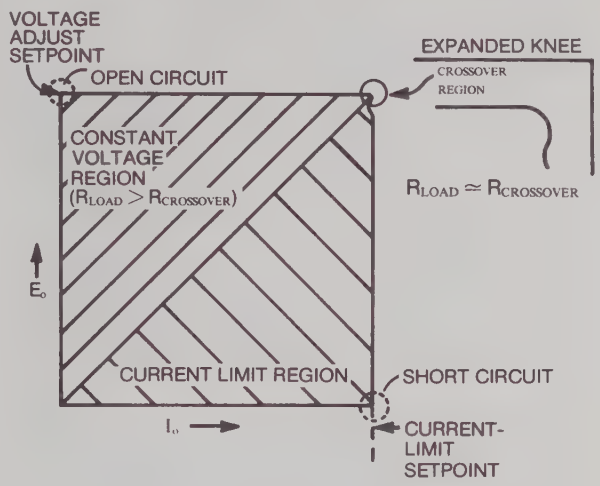


Figure 10. Current Limit Characteristic

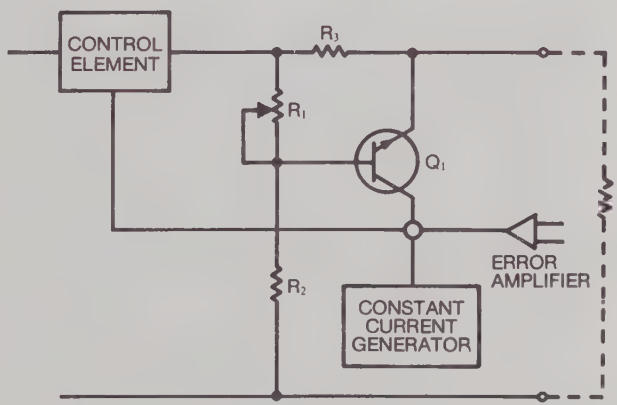


Figure 11. Current Foldback Circuit

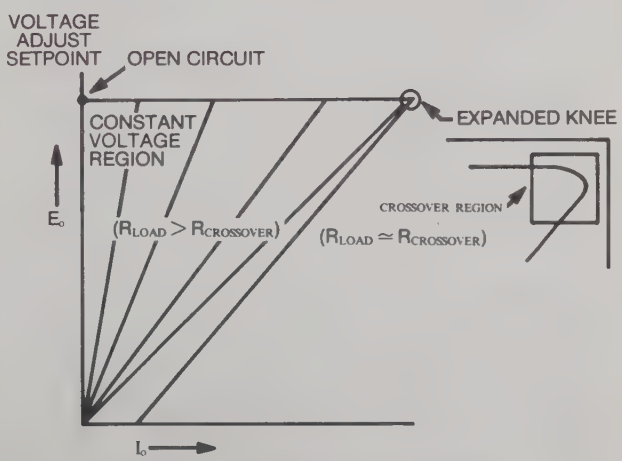


Figure 12. Current Foldback Characteristic

Selecting The Most Efficient Supply

Energy Cost Consideration

In these times of world-wide energy shortages, the cost of electricity becomes a major factor in the cost of operating a power supply system. Relatively small improvements in efficiency result in large reductions in the kilowatt input required from the power line, and therefore a significant reduction in the yearly operating costs.

Consider the changeover from a series regulator, which typically could run at 50% efficiency, to a high-frequency switching supply running at 75% efficiency, on a supply which delivers 28V @ 36 amps (1kW output).

(1) The series regulator consumes	2kW
(2) The switcher consumes	1.33kW

At 6¢ per kW-hr, over a year's period, the cost savings of the switcher will be $350.

Heat-Loss Considerations

The heat losses in the power supply become a major factor in the reliability of both the power supply electronic components and in associated electronic equipment mounted in the same cabinet enclosure. Component reliability is greatly improved by lowering the component ambient temperature (typically, a 10°C reduction can double the life).

Since the heat loss watts will determine the ultimate equipment cabinet temperature, then a comparison of efficiencies will enable one to estimate the relative cabinet temperature rise.

Consider again the example above:
(1) The series regulator has a power loss of 1kW.

(2) The switcher has a power loss of only 0.33kW. Therefore, if the useful output power of 1kW is dissipated elsewhere, then the power supply cabinet of the switcher would have only one third of the temperature rise of the series regulator (typically, a 30°C rise for the series regulator would only be 10°C rise for the switcher).

Normally, the equipment cabinet would dissipate the entire input of the regulator. In this case, the relative temperature rise would be 1.33/2.00 or 33.5% lower for the switcher. (A 60°C rise series regulator cabinet would drop to 40°C). Note that the air conditioning or fan-loads would also drop as noted above, when using the higher efficiency model. This will save additional energy costs.

Comparison of Regulator Types

When efficiency is important, which power supply type should be selected? While the specifications generally include the typical efficiency to be expected, some general guidance can be offerred as to the heat choice.

Type of Regulator	Typical Efficiency
Series-pass	30 - 50%
Pre-regulator series-pass	40 - 60%
Phase-control	60 - 80%
Ferro Resonant	60 - 80%
High-frequency switcher	65 - 85%

The Series Pass-Type offers the lowest efficiency, especially for the 5V output level. In low output power applications (under 150 watts), this type is generally preferred for its excellent performance specifications, simplicity and low-cost. At low power levels, the low efficiency is not a major consideration.

The Sorensen QSA, PTM & MMS/CMS models are in this class. The Sorensen QRD models are wide-range versions of this class.

Pre-Regulator Series-Type offers some improvement in efficiency over the series-type. The major application of this type is in wide-range output voltage supplies (e.g., 0-40V). The pre-regulator greatly improves the efficiency at the lower output voltage setting. This supply should be specified (in place of the series-type) on wide-range units where the power output exceeds about 150 watts. Higher efficiency wide-range units are discussed below, but the pre-regulator series-type offers the best performance specification in the 200 to 2000 watt power output range.

The Sorensen SRL models are in this class.

The Phase Control Regulator offers efficiency figures which are notably higher than the series type. In effect, this type of supply is a low-frequency (60Hz) switching supply. Its efficiency is quite close to that of the HF switcher discussed on the next page.

The phase-control type is available up to very high-power levels (such as 10 to 20kW), where no other type is generally available.

This type is generally offerred as a wide-range output (e.g., 0-600 volts). The Sorensen DCR-A & B models are in this class.

Ferro Resonant Regulator offers efficiency figures essentially equal to the phase control regulator discussed above. It is essentially a 60Hz constant voltage transformer which utilizes a magnetic flux simulation principle. The constant ac voltage is then rectified and filtered to provide a dc output.

It is subject to several severe limitations which do not apply to the other types of regulators:

(1) It is a resonant device which limits the line frequency to a narrow range (typically 60Hz ± 5%).

(2) It is an open loop regulator so that any load current change results in a sizeable output voltage change (typically 10% for a 20 to 100% load current change).

The major advantage of this type is that it is a very simple regulator and is therefore highly reliable. It is also slow-responding (typical 200 milliseconds) to load current changes. Note that the Sorensen line does not include this type of regulator.

The HF Switcher Regulator offers the highest possible efficiency, quite similar to the phase-control type discussed previously. This type also offers the lightest weight and smallest volume. It becomes the first choice for medium output power supplies (200 to 1500 watts) where the other specifications are acceptable.

The Sorensen SSD, STM, SRX, SLC, SLC-B and SLT models are in this class.

Operating Features

Introduction

While power-supply designers continually strive to develop a supply that provides an output which is independent of ambient-temperature variations, input-line voltage swings, load changes, etc., they also realize that such a supply would have limited value if it did not, at the same time, satisfy the ever-increasing demands for greater versatility.

The system designer, for example, has little use for a supply which is incapable of parallel operation when his test system requires a regulated-voltage, high-current source. Nor has he much use for a supply whose output cannot be altered by remote command — if such is his need.

The system designer's requirements are not unique. Even supplies initially specified for unsophisticated applications are sometimes required to demonstrate their full capabilities. In an attempt to anticipate the broad applications in which a power supply might be used, Sorensen has incorporated many custom operating features into its standard-product line. These include the capability for changing the output in response to remote external command (remote programming), monitoring and regulating the output voltage at the load terminals (remote sensing), and series and parallel operation.

Remote Sensing

The power-supply characteristic which is of the utmost concern to most power-supply users is line and load regulation. Power supplies today offer combined regulations to ± .001% of rated output, with some even better. To look at .001% in another way, consider that it is 1 part in 100,000 or .4mV in a 40-volt supply operating at E_{max}. In any case, it is an extremely small number. The regulation specification is obtained by testing the supply with the load located in close proximity to the supply output terminals. This is a reasonable way of specifying a product used in diverse applications. Consider this example: a 40-volt, 5-ampere supply with a voltage regulation of .001% is to be used in an application in which random load changes of 4 amperes are expected. If a total of 10 feet of No. 20 wire (≅10 milliohms/ft) is used as load leads, then voltage variations at the load terminals will be 400mV as opposed to 0.4mV at the power-supply terminals. Figure 13 illustrates this example.

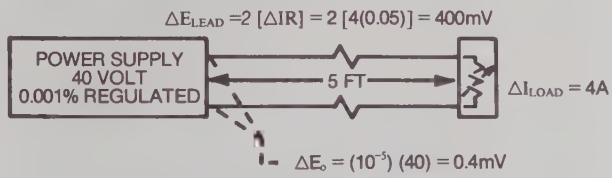


Figure 13. Local vs Remote Regulation

There are a number of ways in which this effect could be reduced. The load leads, for example, could be made oversized or the distance between supply and load could be shortened. Neither is entirely satisfactory nor in many cases practical. However, the entire effect can be eliminated.

As may be recalled from the discussion under *Principles of Operation*, voltage regulation is achieved by varying a series impedance or duty cycle in response to voltage variations *sensed* across the output terminals (see Figure 3). If instead of sensing across the output terminals, the sensing points were shifted to the load, regulation would then occur at the load, and the term "line and load regulation" would no longer be a misnomer. This is, in fact, what is done. All quality power supplies incorporate a *remote-sensing* feature which, through a few elementary steps, achieves regulation at the load. Figure 14, which is a modification of the output section of Figure 3, illustrates a typical configuration. Adaption to the remote-sensing configuration is greatly facilitated by design of the terminal board used on all Sorensen power supplies. It is simply a barrier-strip board with links (or wires) fitted between the output and sensing terminals.

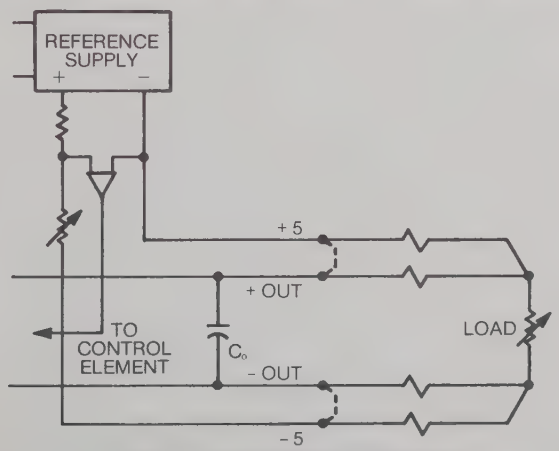


Figure 14. Remote Sensing Configuration

Removal of the links or wires and interconnection of the remote load and sensing terminals completes the conversion. The load leads now form part of the closed-loop system, and variations in their IR drops do not affect the voltage at the load.

Most laboratory supplies incorporate a front-panel mounted meter which, depending upon the manufacturer's point of view, may be connected internally across the sense or across the output terminals. If placed across the output terminals it would, during remote or local sensing operation, indicate the voltage across these terminals and not across the load. By connecting the meter across the sensing terminals, load voltage is indicated when remote sensing is used and supply voltage is displayed when local sensing is the operational mode. When possible, Sorensen connects the meter internally across the sense terminals, feeling that this serves the best interest of the majority of users and leads to less misinterpretation.

Occasionally, in power-supply literature, reports of "remote sensing compensating for load-lead drops" are found. Often this is misconstrued by a few to mean that the power supply somehow extends its maximum output voltage rating to include the load-lead drop. If a supply is rated at 60 volts max. and the load-lead drops total 3 volts, then the maximum voltage that the supply can deliver across the load is 57 volts and no more. "Compensation" merely indicates that there is a regulated voltage across the load.

For most Sorensen power supplies, the sensing current is 10 milliamperes, although for others it is as high as 100. In any case, the current is sufficiently low that the wire size used for sensing leads is inconsequential. However, it should be noted that the leads are susceptible to electromagnetic interference and that any pickup will be processed as an error signal. The result is an overall increase in PARD. To reduce this pickup it is recommended that a shielded twisted cable be used for sensing leads. The load end of the shield should be left unterminated; the power-supply end should be connected to the ground terminal. Although shielded cable is preferable, a twisted pair may suffice. Four twists per inch usually yields good results.

While remote sensing does bring regulation to the load, its use does affect other power-supply characteristics. For example, the output impedance at medium and high frequencies is determined by the output capacitor and its leads. When remote sensing is employed, the load-lead inductance becomes lumped with the capacitance-lead inductance. As a result, the output impedance is substantially higher. There is, however, a practical remedy; disconnect the internal capacitor and connect it, or one that is identical in all specifications, across the load. This solution not only eliminates the deleterious effect on output impedance but also negates the effects of remote sensing on transient response. Inasmuch as a transient condition usually is caused by an abrupt load change, it may be considered to be a high-frequency characteristic. It has already been noted that the output capacitor and its leads determine the high frequency characteristic; lumping, therefore, of power leads with capacitor leads, when remote sensing is employed greatly increases the transient response time.

Remote Programming

From the standpoint of versatility, remote programming is by far the most useful and probably most used power-supply feature. The ability to alter a supply's output voltage or current in response to a remote command is widely employed in the control of industrial processes, component batch testing, in the implementation of servo-system design, and in numerous quality-assurance programs.

With remote programming, the supply's output may be altered in steps, made continuously variable or made to vary around some fixed dc level The concept underlying remote programming is simple. As may be recalled from the discussion in *Principles of Operation*, local control over the output was achieved by placing a potentiometer in the sensing (or *programming*) network. A variation of the same technique is used in remote programming. In most Sorensen supplies, the sensing network is made available to an external control device or network through a line-and-terminal board arrangement similar to that used in remote sensing. Others utilize a different physical arrangment. The electrical principle, nonetheless, is identical. Figure 15 illustrates a typical remote-programming configuration.

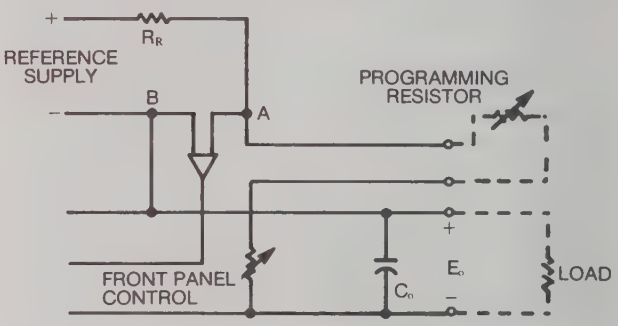


Figure 15. Typical Remote Programming Configuration

Resistance-Programming Coefficent

Obviously, in order to resistance-program a power supply, calculation of the programming resistances that will give each desired output is a prerequisite. This is readily accomplished, since all programmable power supplies have constant, predetermined programming coefficients, or ohms/volt sensitivities.

The constancy of the coefficient is traceable to the comparison amplifier which, in Figure 15, maintains points A and B at zero potential with respect to each other. The entire output of the reference supply, therefore, is dropped across resistor R_R = 887 ohms. Allowing for the amplifier current, the current through the front-panel control would then be 10mA. For each 100

ohms through which this current passes, one volt of output would be developed. This supply then has a programming coefficient, or ohms/volt sensitivity, of 100 ohms/volt.

When selecting a programming resistor, the temperature sensitivity and voltage rating of the resistor should be considered. Any changes in resistance due to temperature gradients whether traceable to ambient effects or self-heating will cause directly proportional output variations. Good practice dictates the use of a resistor with a temperature coefficient equal to or less than 20 ppm/°C and a wattage rating at least 10 times the power dissipated, i.e., I_{2prog} R_{prog} x 10.

The precautionary procedures concerning electromagnetic pickup that were recommended under *Remote Sensing* are equally applicable to remote-programming leads.

The preceding discussion on resistance programming, though slanted toward voltage-mode programming, also applies to current-mode resistance programming with, of course, the necessary alterations in units, e.g., ohms/ampere instead of ohms/volt.

Inasmuch as the output voltage tracks and is directly proportional to the programming resistance, an open programming circuit, corresponding to an infinite programming resistance, will drive the output voltage higher than the maximum rating of the supply. While it is unlikely that such a condition would ever exist with a fixed programming resistor, cases of programming leads coming loose or being disconnected during operation are not unknown. However, the probability of occurrence becomes greater as more complex resistance networks are used. For example, if a break-before-make switch is employed, the instant of switching represents an infinite impedance. Make-before-break switches, too, can lead to increased switching times if the programming networks are not properly designed.

Signal Programming

Many applications call for programmed outputs which are not characterized by the step functions associated with resistance programming. Sinusoidal and triangular characteristics are among the more conventional outputs required. These and most other linear and nonlinear time-varying outputs are readily obtained through signal programming.

The signal-programming configuration is similar to that illustrated in Figure 15 with one exception: the programming resistor is replaced with a voltage source. The source must meet certain compatibility requirements. It must, for example, be capable of absorbing the programming current and be capable of producing a clean signal. With regard to the latter any noise and ripple generated by the source, and within the bandwidth of the supply, will be reproduced in the output characteristic.

In most Sorensen transistor power supplies, coefficients for voltage-signal programming in the voltage mode are a volt/volt, i.e., one volt of programming signal is required to produce one volt of output. The supply then is essentially a unity-gain power amplifier. The current-mode signal programming coefficients differ widely with design and model. Typically, they range from 0.2 to 2 volts/ampere.

Digital-To-Analog Converter Programming

In many modern systems, the computer is used to program the power supply in response to a digital program. To couple the computer to the power supply, a digital-to-analog converter is required (DAC). This device translates the digital computer output into an analog voltage signal. The analog signal can then be used to program the power supply, as discussed above under *Signal Programming*.

This device also serves to isolate the digital signal from the power supply output voltages. The Sorensen DAC is called the DAP (digital to analog programmer). The DAP can be used to program both output volts and output current. The 488-DAP unit provides two independent channels which can be used for volts and current control of the same supply, or could be used for controlling two separate power supply output voltages.

This device will interface with the industry-standard 488 Bus.

Programming Response Time

Obviously, the response of a standard programmable supply is not instantaneous. Primary time delays are traceable to (1) the large output capacitor which gives the supply its high-stability characteristic and acts as a low-pass filter, and (2) R-C networks in the feedback loop that limit output overshoots during load transients. In combination, these two act as a pair of cascaded filter networks and introduce delays that are not only a function of the capacitance values but also of the load. The magnitude of the delay, being dependent in part upon the load, differs from application to application. Typically, however, the programming rate is about one volt per millisecond.

While 1 volt/millisecond is an adequate programming rate for many applications, the nature of modern technology is such that rates of 10^3 and higher are often required. To achieve this speed, without significant degradation in stability, PARD characteristics and transient response, is the goal of much of the recent advanced work in power-supply development.

The first product line resulting from an intense development program at Sorensen is the QRD high-speed programmable supply. The design of the QRD incorporates novel circuit techniques which endow it with state-of-the-art programming speed and at the same time give it excellent response ripple and stability characteristics.

Inasmuch as high-speed programming represents a recent technological breakthrough, a universally acceptable definition of programming speed has not been formulated. In the interim, Sorensen has elected to specify programming speed in two ways, each corresponding to the more common programming function: step and sinusoidal.

The step-input definition specifies programming time as the maximum time required for the power-supply output to change from its preprogrammed level to the programmed value as measured at the 10% and 90% points. Figure 16 illustrates the definition with the typical up- and down-programming characteristics of the Sorensen Model QRD 30-1. Note the rapid programming times.

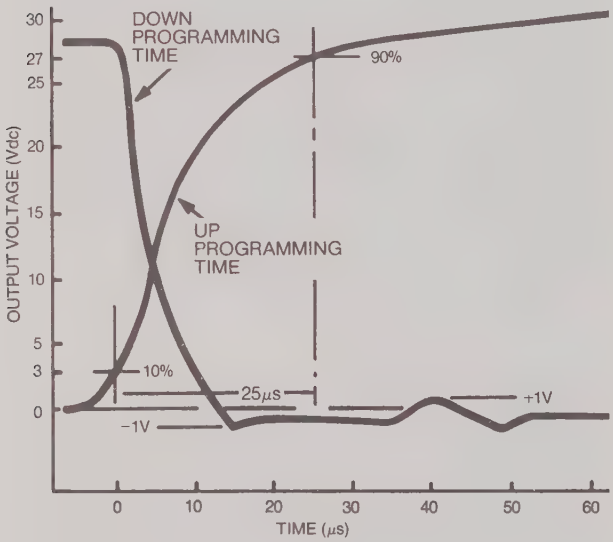


Figure 16. Typical Up and Down Programming Time Characteristics

The sinusoidal-input specification defines programming time in terms of the maximum sinusoidal input frequency that the supply will reproduce without distortion. In the development of the QRD Series, analysis showed an inverse relationship between the maximum input frequency and the pk-pk value of the input sine wave. Empirical data yielded the following approximation: $f_{max} = \frac{230{,}000}{E_{pp}}$ Hz when the dc output of the supply is set to $E_{max}/2$. Figure 17 illustrates the magnitude of variation in the approximation for a typical set of QRD models. One other definition of programming time, i.e., slewing rate, may be encountered. While slewing rate is a convenient term by which a few power-supply manufacturers choose to specify programming time, users not familiar with its limitations may be astounded by the magnitude of the rates which it yields. But it is, at best, a marginally adequate term, fine for some applications, disappointing in others.

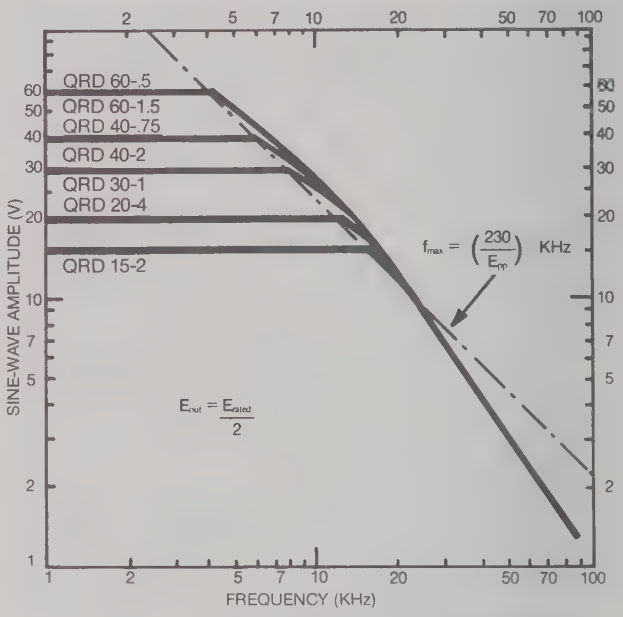


Figure 17. Programming Sinusoidal Frequency Response

Multiunit Operation

With the introduction of high-voltage, high-current power supplies, e.g., Sorensen's DCR Series, series and parallel requirements have become limited. However, both do and will continue to find wide usage in short-term laboratory applications where flexibility is a much-valued asset.

There are two basic types of parallel operation, and two in series. In the following section each of these will be discussed in terms of advantages and disadvantages.

Direct Paralleling

The intent of any power-supply paralleling technique is to meet the current requirement of the load by increasing the current capabilities of the source. When constant-voltage/constant-current supplies are available, direct paralleling may be used. With this method, the current crossover value of each supply is chosen so that the sum is equal to or greater than the load current required.

An attempt is then made to match as closely as possible the output voltage of each unit. This voltage is, of course, the voltage across the load. Next, all supplies are placed in a standard parallel configuration about the load (see Figure 18). When the load is applied, the supply with the highest output voltage (it is impossible to match exactly the output of all units) will provide current to the load. As this current becomes equal to the crossover current, the output voltage begins to drop, and the supply with the next highest voltage assumes the load rejected by the first. This process continues until the load current requirement is satisfied.

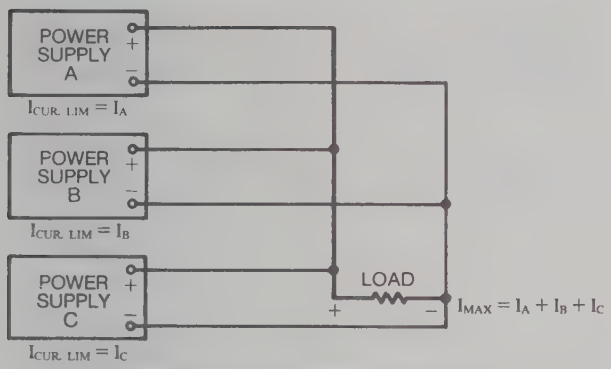


Figure 18. Direct Paralleling Configuration

An unlimited number of units may be direct-paralleled. As will be discussed in the next section, limitations on numbers of units is one of the drawbacks of master-slave paralleling and hence constitutes an advantage for direct paralleling. In direct paralleling, regulation does deteriorate and becomes the sum of the regulations of all units paralleled plus the sum of the differences, between units, in output voltage.

Master-Slave Paralleling

In master-slave operation one unit, the master, supplies the drive or control signal to the control elements of all other units (slaves) and to the master itself. Inasmuch as the feedback networks in all slave units have been disabled prior to operation, the master unit regulates the output voltage of all units. The load current is simultaneously shared by all units, and has a maximum value that is the product of the number of parallel units and the current limit or crossover setting of the master unit derated to 90% (to allow for unbalances).

Both the primary advantage and disadvantage of master-slave paralleling result from the interconnection of master-unit drive signal and slave-unit control elements. In this configuration, the system regulation is the regulation characteristic of the master unit, a much closer regulation than would be achieved in direct paralleling. However, it is the strength of this drive signal which determines the number of units which may be paralleled. The current deration provides a cushion for the typical tolerances which accompany current sharing. Figure 19 illustrates a typical master-slave

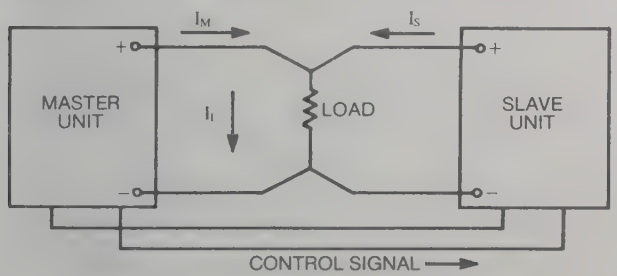


Figure 19. Master-Slave Paralleling Configuration

configuration. The slave output I_S will be forced (approximately) equal to the master output I_M. Then the load current I_L will equal the sum of I_M and I_S (or 2 I_M). It should be noted that most Sorensen supplies allow access to the internal control network through an external link-and-terminal board arrangement. This feature facilitates (1) the connetion of slave-unit control elements to the master-unit drive network, and (2) the disablement of slave-unit feedback networks.

Series Operation

Series Operation is designed for those applications which require a higher voltage than a single power-supply can provide. For Sorensen supplies, series operation is effected by simply connecting the supplies in a standard series configuration (see Figure 20).

The maximum number of units which may be connected in series is limited by the maximum dc-to-ground voltage for which the supply is rated. For example, five 40-volt units each with a 200V dc output terminal-to-ground rating may be series-connected. System output regulation as would be expected is the sum of the unit regulations.

Sorensen recommends that, when using units in series, a diode be connected across each set of output terminals as shown in Figure 20. If a unit becomes disabled in series operation the diode protects the failed unit from the reverse voltage derived from the functioning supplies. Protection-diode type numbers are listed in most instruction manuals or may be obtained by writing or calling Sorensen.

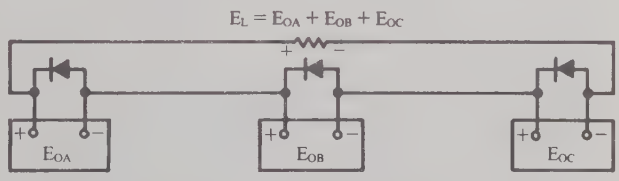


Figure 20. Series Operation Configuration

Master-Slave Series Operation

Similar to Master-Slave Parallel Operation (above), the Master Unit is utilized to supply the control signal to the Slave unit. This may be accomplished by removing the internal reference voltage from the slave unit and replacing it with the output voltage from the Master. If the Slave unit is then configured so that it is a unity-gain device, the Slave output voltage will exactly equal Unit of the Master. See Figure 21.

The Slave Output V_s will be forced equal to that of the Master V_m. Then, the load voltage will equal the sum of V_m and V_s (or $2V_m$). (Diodes CR_A & CR_B prevent reverse voltage from appearing across a disabled supply).

Both Master and Slave should have their current limiters set for the desired maximum load current, for overload protection. Note: Each power-supply model has

its own special scheme for accomplishing the above so that the Instruction Manual must be consulted. (Some models do not permit this operation).

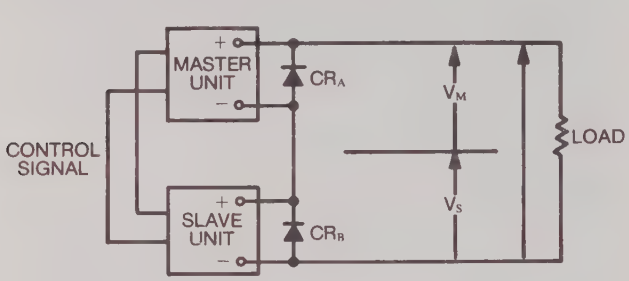


Figure 21. Master-Slave Series Operation

Verifying Specifications

Introduction

In the past the power-supply industry has been criticized for making exorbitant performance claims and in general for playing the "spec" game. Much of this criticism has come from power-supply users and therefore should be considered valid. The customer who has purchased a power supply that does not perform as he thought it would assumes the supply to be poorly designed or fabricated, and hence, the manufacturer has misrepresented his product. Such is rarely the case. A power supply may appear to perform poorly if the measurement techniques employed are incorrect or if the specification definitions are poorly understood.

To help in diminishing the effects of these sources of irritation, Sorensen has developed a set of precise specification definitions (see Glossary of Terms) and a systematic set of procedures for verifying the more important output specifications. The latter constitutes the remainder of this section.

Premeasurement Considerations

The techniques used in measuring the characteristics of precisely regulated supplies should be every bit as good as those employed in evaluating the performance of more sophisticated laboratory instruments. Poor connections, careless choice of test location, disregard of test-system-generated noise, etc., can only detrimentally influence test results. A few general rules that should be observed when testing either constant-voltage or constant-current specifications follow:

1. Connect all test instruments at the power-supply sensing terminals, not at the load. Connect the load to the load terminals.

The deleterious effects of measuring at the load may be illustrated by an example. Consider a 10V, 1A unit with a specified load regulation of ±0.01% (±1.0mV). With the output set to 10V, the voltage deviation could be 2mV. But this is at the supply terminals. Just one foot of No. 23 load-lead wire is sufficient to drop 20mV (eight times the maximum deviation permitted by the regulation specifications). Results from a test setup of this kind would, of course, be invalid.

Another not-so-obvious example of the same problem is encountered when measurements are made at front panel binding-post terminals instead of the barrier-type "sense" terminals. The binding post, in essence, introduces a resistance between the test leads and the regulated (sensed) output points. This resistance results in a voltage drop which is subtracted from the output voltage before measurement. It, therefore, has the same effect as load leads. Figure 22 gives both schematic and physical representations of a binding post and its unregulated voltage drop. Note that exactly the same problem may be encountered when the load leads are connected to the sense terminals. (Figure 23 illustrates correct load-lead location.)

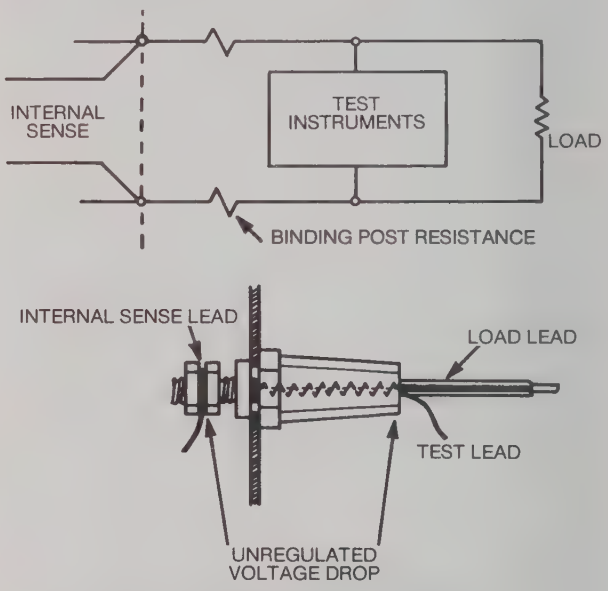


Figure 22. Binding Post Induced Resistance

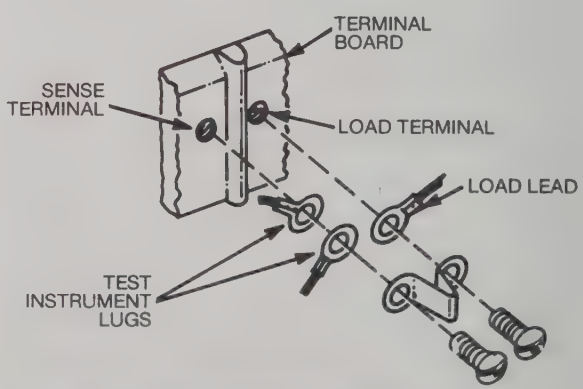


Figure 23. Recommended Rear Terminal Connections

2. Use shielded twisted wire or coaxial cable for test leads. Stray pickup, many times, can and does substantially influence the extremely small deviations being measured.

3. Terminate test leads with solder or spade-type lugs.

Alligator clips, or other similar types of connectors, may introduce undesirable contact resistances and result in false readings.

4. Connect leads from each measuring instrument to power-supply sense terminals.

Interaction or coupling effects sometimes cause inaccurate measurements.

5. After connecting the test system, check for system-generated noise and ripple.

Ground loops sometimes introduce noise and ripple not related to power supply's performance.

Performance Verification

Constant Voltage Specifications

Regulation

Figure 24 illustrates the general test-instrument configuration recommended for evaluating the performance of constant-voltage supplies. The oscilloscope and true RMS voltmeters are not required for regulation measurements. Note that the maximum current rating of the autotransformer should be 10% to 20% higher than the maximum ac current drawn by the supply. The latter is listed either on the data sheet, or in the instruction manual that accompanies each unit.

To check voltage regulation, the unit output voltage, with no load applied, is adjusted to its maximum rating and the ac input is set at nominal, i.e., 115V ac. Next, the differential-voltmeter is nulled and the load is applied until the current drawn is at rated maximum. The deviation from null is recorded. Following this, the ac voltage is decreased to minimum rated, the null-position is re-established, and the input voltage is increased to maximum rated. The observed deviation from null is added to that previously recorded — the sum representing the total line and load regulation. For comparison purposes, the specified percentage regulation may be converted into millivolts by multiplying the percentage by two, converting to decimal and multiplying the results by the maximum rated output voltage.

PARD

To verify the PARD specification, a true RMS voltmeter and an oscilloscope should be placed across the output terminals as shown in Figure 24. Note that the oscilloscope should be ac coupled to preclude the influence of dc drift. In selecting a voltmeter and an oscilloscope, assure that their bandwidths are equal to or greater than those specified on the data sheet or in the instruction manual. PARD data is taken at nominal input and full-rated voltage and current output. The ripple indicated by the voltmeter and pk-pk voltage displayed on oscilloscope should be equal to or less than specifications. Note that, if a unit has a fast-programming mode, PARD may be checked in this mode by first performing the necessry conversion procedures and again comparing indicated levels with those specified.

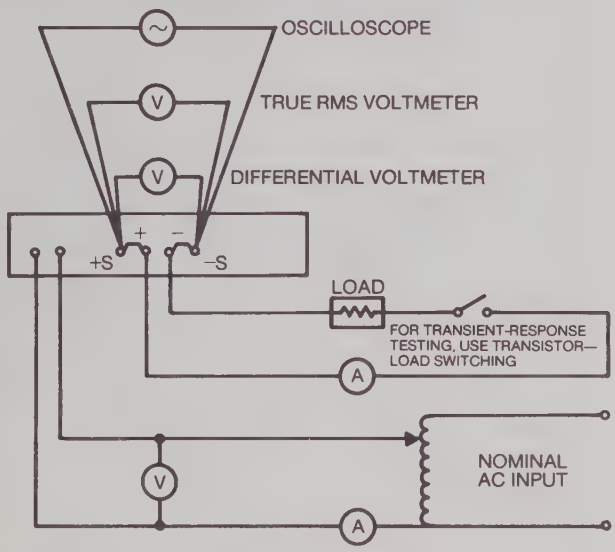


Figure 24. Constant-Voltage Specification Test Arrangement

Transient Response Time

Transient response time or the time it takes for the output voltage to return to a specified band following a step-load change, either full-load to no-load or no-load to full-load, is accomplished by electronically switching the load and observing the response characteristic on an oscilloscope. Figure 24 illustrates the configuration. The differential voltmeter and true RMS voltmeter are not used in order to reduce inductive delays introduced by the test system. Test leads should be made as short as possible and the load should be noninductive. Note that switching should be accomplished in 1/10 or 1/20 of the rated response time of the supply.

Drift

Drift is a long-term characteristic which is evaluated under controlled conditions of constant load, line voltage, and ambient temperature. The results are usually recorded on a strip-chart recorder connected across the load terminals of the supply. The stability of the recorder is a primary characteristic to be considered when checking drift. Assure that it is sufficiently small so as not to influence the test results. The drift specification normally applies over an eight-hour period after warm-up, with warm-up in constant voltage operation usually set at one-half hour. The particulars are either listed on the data sheet or in the instruction manual.

Programming Time

Programming time is evaluated by connecting a mercury-wetted relay in series with the programming resistor and then driving the relay at 60Hz. An oscilloscope should be connected across the output terminals to display the characteristic. Due to the widespread use of a number of differing programming time definitions, the Sorensen definition should be reread when evaluating the results.

Constant-Current Specifications

The instruments and techniques used in verifying constant-current specifications are quite similar to those employed in evaluating constant-voltage performance. Figure 25 illustrates the general test-system configuration. Note that it is not the current that is monitored, rather it is the voltage drop across a precision laboratory shunt. This resistor should be judiciously selected to be noninductive and to have a power dissipation rating at least ten times that required. The load must be noninductive and be capable of absorbing the full compliance voltage. (The compliance voltage is defined as $E_c = I_{const} R_{load}$. Depending upon the crossover characteristic (see Figure 7), it may range from 95% to 98% of the maximum voltage obtainable in voltage mode operation.)

Regulation

In measuring current-mode regulation, the true RMS voltmeter and oscilloscope are not needed. For models equipped with a dual-function output meter, an additional voltmeter connected across the load terminals is required. The recommended procedure follows: adjust the no-load output voltage to maximum rated, and then apply load until the output voltage drops to the maximum compliance rating (listed in instruction manual). The differential voltmeter is then nulled, and the shorting switch is closed. Any steady-state deviation from null is recorded. Next, the switch is opened and the input line voltage is set at minimum rated. The deviation from the null position is summed with that previously recorded. The total may then be converted to amperes and compared with the specified regulation. Note that the conversion factor is the reciprocal of the shunt resistance.

PARD

In verifying current-mode PARD, a true RMS voltmeter and an oscilloscope are connected across the precision shunt as shown in Figure 25. The differential voltmeter is not used. To preclude dc drift effects, the oscilloscope should be ac coupled to the shunt.

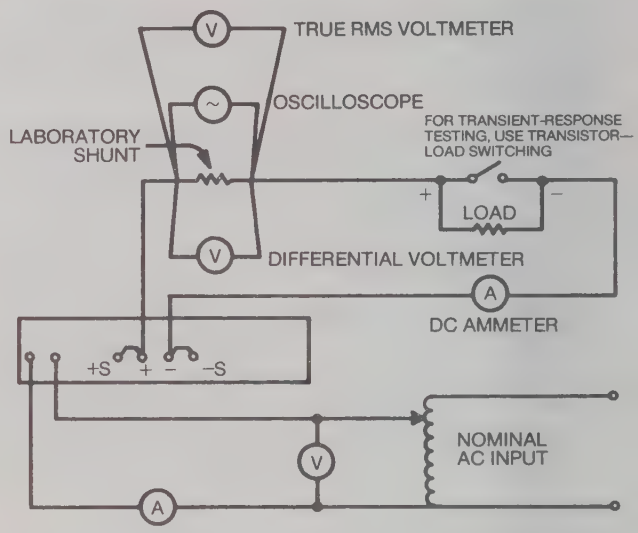


Figure 25. Constant-Current Specification Test Arrangement

The procedural sequence follows: with no load applied and the input voltage set to maximum; then load is applied until the output voltage drops to the maximum compliance. (For models equipped with a single output meter, an additional voltmeter will be required to measure the compliance voltage.) The true RMS voltmeter and oscilloscope are then monitored, and ripple and pk-pk noise are noted and compared with the published PARD specification.

Transient Response Time

The only instrument required for transient response time measurements is an oscilloscope (see Figure 25). The load switch should be transistorized to provide rapid switching — less than 1/10 the rated response time. The procedure simply entails monitoring the output terminals as the load is switched from zero to a value that will yield the maximum compliance voltage. Note that the load should be noninductive and that the test leads be as short as possible. Delays in response may be caused by test-system inductances.

Drift

The drift characteristic for the current mode is specified for controlled conditions of constant line, load, and ambient temperature. The unit under test and the load, if possible, should be placed in a temperature-controlled chamber. If this is not possible, the temperature around the unit should be monitored frequently. To guarantee that the load resistance does not change significantly due to self-heating, it should have a dissipation capacity at least ten times that required by the supply's output.

Isolation (Hi-pot) Testing

Most power supplies provide electrical isolation between the ac power line and the dc output voltage. In addition the ac input is isolated from the chassis.

The above isolation is required for safety reasons and is a U.L. requirement. The metal chassis and enclosure is connected to the power line safety ground (green wire) or "earthed" directly.

Similarly, most power supplies provide electrical isolation between the output dc voltage and the chassis ground. This isolation level is much smaller than the ac line isolation voltage level, since most dc output voltages are grounded in actual applications (for safety reasons).

Because of the ac currents which can flow through capacitors used in the supply, the isolation is tested by applying a dc "Hi-pot" voltage rather than an ac voltage. On switching supplies (e.g., Sorensen STM, SSD, SLC-B, SRX, SLC) this test can be very destructive to the power supply and should not be attempted. Instead, the use of an ohmmeter test for isolation is recommended (an ohmmeter reading of greater than 100,000 ohms is considered satisfactory). The ohmmeter should not apply more than 100V dc to the power supply.

Typical isolation test voltages are 1300V dc (for 115V ac input models) for line to chassis (with output connected to chassis) or 200V dc from output to chassis. See caution note above on switching supplies. Consult factory before attempting to make a voltage-isolation test on any supply.

Glossary of Terms*

Absolute Accuracy
The correctness of the indicated value in terms of its deviation from the true or absolute value.

Automatic Crossover
A term applied to bimodal power supplies (constant voltage/constant current) that describes the transferal from one operating mode to the other at a predetermined value of load resistance. Usually the crossover point is preset by means of front-panel controls. (NEMA derived)

Calibration Accuracy
Synonymous with absolute accuracy.

Compliance Range
The load voltage capability of a power supply operating in the constant-current mode (it is analogous to the maximum current rating of a power supply operating in the constant-voltage mode).

Constant-Current Power Supply
A power supply that maintains a stabilized output current within prescribed limits with respect to changes of influence quantities (line, load, ambient, etc.). (NEMA derived)

Constant-Voltage Power Supply
A power supply that maintains a stabilized output voltage within prescribed limits with respect to changes of influence quantities (line, load, ambient, etc.). (NEMA derived)

"Crowbar" Overvoltage Protection
A load protection circuit designed to prevent excessive output voltage. It rapidly places a low resistance shunt across the output terminals of the power supply, thereby initiating action to reduce the output voltage to a low value. (NEMA derived)

Current Limiting
A general term applied to any of three kinds of short circuit or overload protection (see Figures 8, 11 and 13 in Principles of Operation), and which describes the action of limiting the output current to some maximum predetermined value (fixed or adjustable) and automatically restoring the power supply to normal operation when the overload or short circuit is removed. (NEMA derived)

Drift
The maximum change of an output parameter during a specified period of time following a warm-up period, with all external operating and environmental parameter influences maintained constant during the warm-up time and the period of drift measurement. Drift includes the periodic and random deviation (PARD) from dc to a specified upper frequency limit that coincides with the lower frequency limit for PARD. (NEMA derived)

Efficiency
The ratio of the output power to the input power, usually expressed as a percentage.

Harmonic Distortion
The distortion of a sinusoidal wave characterized by the presence of harmonics of the fundamental frequency. Percent Harmonic Distortion is an appropriate figure of merit and is defined as the ratio (in percent) of the square root of the sum of the squares of all RMS harmonic voltages (or currents) to the fundamental.

Operating Temperature Range
The range of ambient temperatures throughout which a supply will meet all of its ascribed output specifications.

Output Impedance
Output impedance or dynamic output impedance is the impedance presented by the power supply to the load. It is calculated from the ratio of the change in output voltage (at the prescribed terminals) to the change in load current causing the change. The impedance is specified from dc to a stated maximum ac.

Overshoot
A transient voltage or current rise above the regulation band caused by large step-like changes in the load or input line or by the application or disconnection of input power. (NEMA derived)

Parallel Operation
Interconnection of two or more power supplies in a manner as to obtain summation of their output currents. In general, Sorensen power supplies may be operated in either a direct or a master-slave configuration (see operating features). (NEMA derived)

*Definitions derived from NEMA Standards Publication Pub. No. PY1-1972 are so indicated.

PARD
An acronym for Periodic and Random Deviation which is defined as the deviation in the regulated output parameter, voltage or current, over a specified bandwidth with all external and environmental parameters held constant. The term excludes deviations attributed to drift. (NEMA derived)

Phase Shift
The difference between corresponding points on input- and output-signal wave shapes (not affected by magnitude) expressed as degrees lead or lag.

Programming Speed
The rate of change of a programmed output parameter in response to a program command.

Regulation:
a. Line — The maximum steady-state differential in the controlled output parameter resulting from a full-range change in source voltage.
b. Load — The maximum steady-state differential in the controlled output parameter resulting from a full-range load change.
c. Line and Load Combined — The maximum steady-state differential in the controlled output parameter resulting from concurrent full-range change in load and input voltage, both in the direction which represents the worst case.

Repeatability
The closeness in agreement among a number of consecutive measurements of the controlled output parameter, with each measurement following an identically programmed input command.

Remote Programming
A power-supply feature whereby the controlled output parameter, voltage or current, may be controlled through the application of external resistances, voltage signals, or current signals to designated external terminals. (NEMA derived)

Remote Sensing
A standard feature of most quality power supplies which allows the user to shift the regulation point from the supply's output terminals to an external location. The variations normally produced in the load leads by local changes are corrected by the sensing and regulating networks (see operating features). (NEMA derived)

Resolution
The minimum discernible change in the controlled output parameter that can be made with the applicable front-panel control, (NEMA derived)

Ripple
Those deviations in the controlled output parameter which are harmonically related in frequency to the applied input power and any internally generated switching frequencies. Normally, defined as an average value (rms) or the maximum peak-to-peak amplitude. More recently, PARD, which includes a bandwidth limit, has been used when defining ripple. (NEMA derived)

Series Operation
The operation of two or more power supplies with the positive output terminal of one connected to negative output terminal of another, so that the output voltages of the supplies are additive. (NEMA derived)

Settling Effect
The relatively slow change of an output parameter which follows an initial variation of the same parameter and exists as an added output variation.

Sinusoidal Frequency Response
The maximum sinusoidal frequency to which a fast-programmable power supply will respond with negligible distortion in the output waveform.

Slewing Rate
A term sometimes used to describe the response speed of a fast-programmable power supply. It is generally defined as the slope of the chord to the first time constant of the exponential response.

Stability — See Drift

Temperature Coefficient (Output Effect Coefficient)
The percent change in the controlled output parameter due to a 1°C change in ambient operating temperature within the operating temperature range. (NEMA derived)

Transient Response Time
Transient response time is defined as that time interval following an abrupt change of influence quantity (load or line) for the controlled output parameter to leave and to return (and stay within) a specific band.

Warm-Up Time
That period, following the application of input power, before a power supply meets its rated performance characteristics. (NEMA derived)

Limited Warranty

Sorensen Company warrants all parts of each power supply to be of sound design, good materials and workmanship, and will repair or exchange any parts proven to be defective under normal use at no charge for a period of 5 years from the date of shipment. Please note that the SLC-B Series carries a warranty period of 2 years and the Miniature Encapsulated Series carries a warranty period of 3 years.

Sorensen's liability under the terms of this warranty is limited to the satisfactory repair or the replacement of defective products which have not been damaged through accident, abuse, misuse, or unauthorized repair. Sorensen shall in no case be liable for any special or consequential damages of any nature.

The unused portion of this warranty is fully transferable from the original purchaser if the Sorensen product is a component of the original purchaser's product or system.

Defects will be corrected by the factory or one of our authorized field service centers throughout the world. All products returned for repair must be shipped freight prepaid and accompanied by a Return Material Authorization. Returned freight is shipped collect.

Sorensen Company
676 Island Pond Road
Manchester, NH 03103 USA
Tel: 603-668-4500
TWX: 710-220-1339

High Power Switching Power Supplies
SSD Series

- 15 models, 5V to 48V dc with power levels up to 1125 watts
- 115/230V ac or 255-345V dc input
- Wide range output voltage adjustment
- Built-in adjustable overvoltage protection on all models
- Remote programming
- Remote sensing
- Logic shutdown for system applications
- Adjustable Current Limiting
- Low ripple and noise through the use of double stage filtering
- Hold-up time typically 80ms half load, 40ms full load
- U.L. listing on Case III models
- 5 year warranty

The SSD Series offers 115/220V ac input selectable from the terminal board.

Specifications

INPUT

Voltage:
98-132V ac single phase
196-264V ac single phase
255-345V dc
SSD 5-225 (1,000 Watt unit):
105-125V ac single phase
210-250V ac single phase
275-325V dc

Frequency:
47-440 Hz operation
without derating
360-440 Hz (double rms ripple spec)

OUTPUT

Regulation:
Line: 0.01% + 1mV
Load: 0.01% + 1mV

Ripple:
Case III and IIIA
Typical: 5mV rms, 20mV pk-pk
Maximum: 8mV rms, 50mV pk-pk
Case IVB
Typical: 12mV rms, 60mV pk-pk
Maximum: 15mV rms, 75mV pk-pk
Case X (SSD 5-225)
Typical: 7mV rms, 80mV pk-pk
Maximum: 10mV rms, 100mV pk-pk

5 Year Warranty

SSD Series
Model Specifications

Temperature Coefficient:
0.01% maximum per°C

Stability:
0.05% maximum for 24 hours after warm-up of 30 minutes

Transient Response Time:
Output voltage returns to within 1% in less than 1.5ms following a step load change of 25% to 75% or 75% to 25%.

Overshoot:
Less than 1% on turn-on, turn-off or power failure.

Overvoltage Protection:
Built-in, adjustable overvoltage protection standard on all models.

Current Limiting:
Automatic, internally adjustable

OPERATING DATA

Efficiency:
65 to 80% depending on model.

Remote Sensing:
Terminals are provided on barrier strip. As long as terminal voltage remains within specified range, there are no basic limitations on load lead drop.

Remote Programming:
Resistance remote programming
1000 ohm/volt
Voltage remote programming
volt/volt

Remote Shutdown:
Output voltage can be shut down by placing 100 ohms or less in shutdown circuit. TTL compatible.

Series Operation:
Up to 100V dc maximum output.

Parallel Operation:
May be directly paralleled without derating.

Soft-Start:
In-rush current is limited by soft-start circuit.

Isolation:
2.1kV dc input to chassis
2.1kV dc input to output
500V dc output to chassis

Ambient Operating Temperature Range:
0 to 70°C

Storage temperature Range:
–55 to +85°C

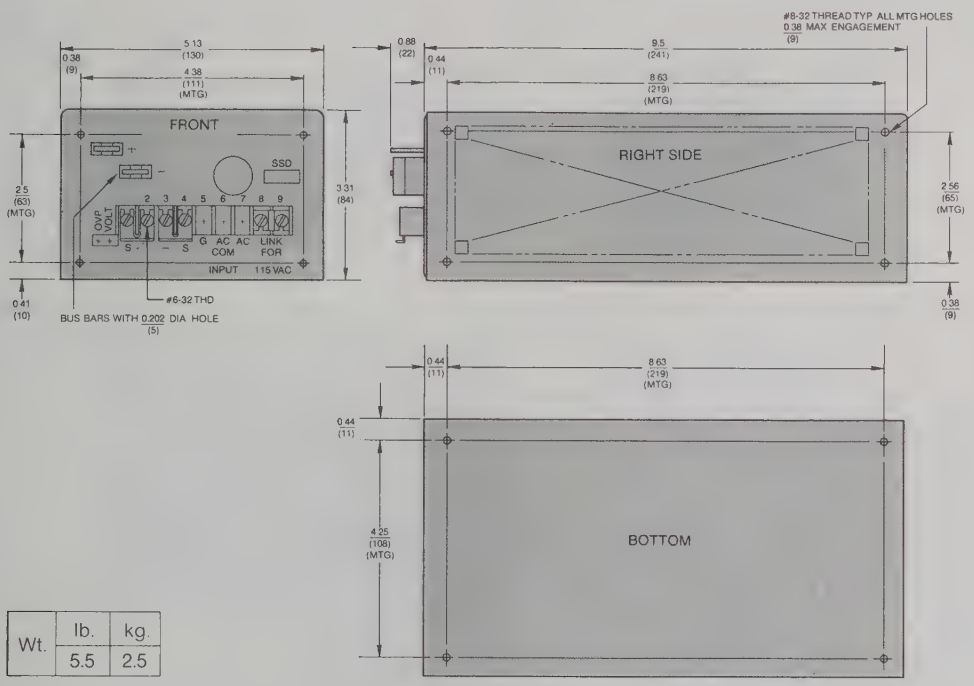
Cooling:
Convection cooled (exception: SSD 5-225 is fan cooled).

Finish:
Textured blue thermal paint.

Model	Nominal Output Voltage V dc	Output Voltage Adjustment V dc		Output Current A dc				Case
		Min.	Max.	40°C	50°C	60°C	70°C	
SSD 5-30	5	4.7	5.5	30.0	27.0	22.5	15.0	III
SSD 5-45	5	4.7	5.5	45.0	40.5	32.8	22.5	IIIA
SSD 5-75	5	4.7	5.5	75.0	67.5	56.2	37.5	IVB
SSD 5-225	5	4.75	5.25	225.0	200.0	165.0	110.0	X (1)
SSD 12-15	12	10.0	13.0	15.0	13.5	11.2	7.5	III
SSD 12-22	12	10.0	13.0	22.0	19.8	16.5	11.0	IIIA
SSD 15-12	15	13.0	17.0	12.0	10.8	9.0	6.0	III
SSD 24-8.5	24	20.0	25.0	8.5	7.6	6.3	4.2	III
SSD 24-13	24	20.0	25.0	13.0	11.7	9.8	6.5	IIIA
SSD 24-22	24	20.0	25.0	22.0	19.8	16.5	11.0	IVB
SSD 28-7	28	25.0	30.0	7.0	6.3	5.2	3.5	III
SSD 28-11	28	25.0	30.0	11.0	9.9	8.3	5.5	IIIA
SSD 36-5	36	32.0	40.0	5.0	4.5	3.7	2.5	III
SSD 36-8	36	32.0	40.0	8.0	7.5	6.0	4.0	IIIA
SSD 48-4	48	42.0	54.0	4.0	3.6	3.0	2.0	III

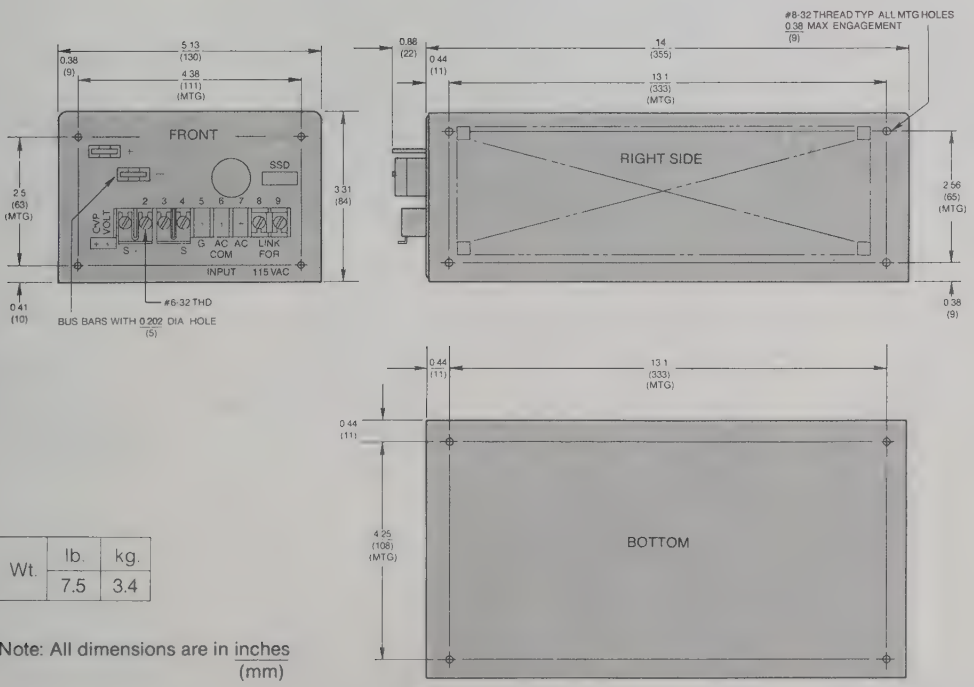
Specifications subject to change without notice.
(1) **Case X (SSD5-225) dimensions:**
Height 4.94 (125mm), Width 11.25 (286mm), Length 16.5 (419mm), Weight 31 lb. (14 Kg).

CASE III



Wt.	lb.	kg.
	5.5	2.5

CASE IIIA

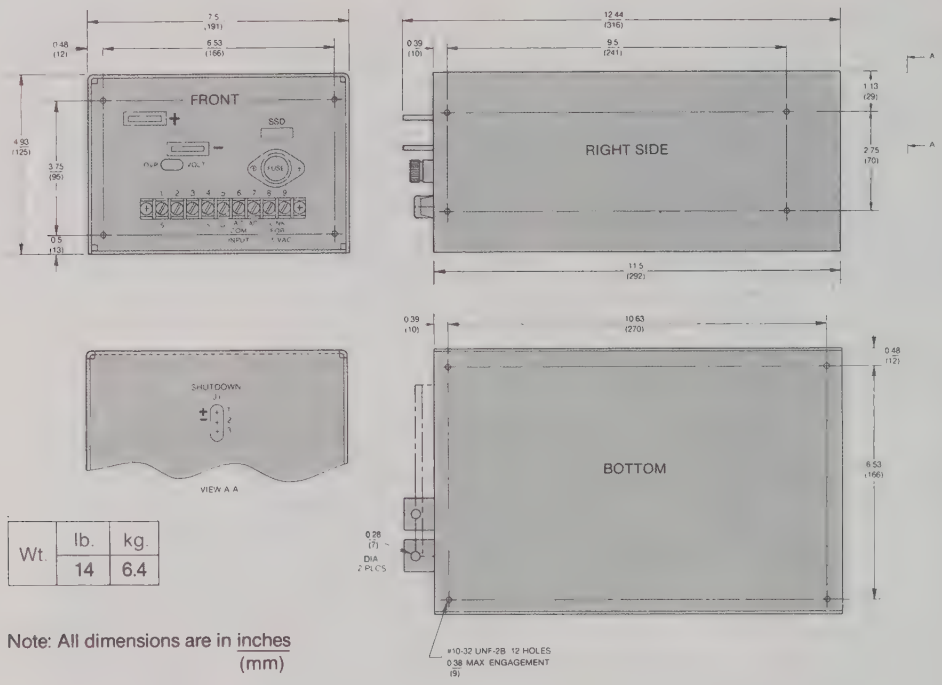


Wt.	lb.	kg.
	7.5	3.4

Note: All dimensions are in inches
(mm)

SSD Series
Dimensional Drawings

CASE IVB



Wt.	lb.	kg.
	14	6.4

Note: All dimensions are in inches (mm)

SSD Series Input Data

Maximum Input Current

Nominal Input Voltage	Case III Amperes	Case IIIA Amperes	Case IVB Amperes	Case X Amperes
115V ac	4.2	5.5	7.0	23.0
208/220/230V ac	2.3	3.0	3.5	11.5
300V dc	1.0	1.5	2.7	8.7

Input Ratings, Typical Efficiency

Case III		Case IIIA		Case IVB		Case X	
SSD Model #	Efficiency %	SSD Model #	Efficiency %	SSD Model #	Efficiency %	SSD Model #	Efficiency %
5-30	68	5-45	68	5-75	72	5-225	69
12-15	75	12-22	75				
15-12	70						
				24-22	74		
24-8.5	75	24-13	75				
28-7	75	28-11	75				
36-5	77						
48-4	78	36-8	75				

Input ratings at nominal line, nominal adjustment, full load (@40°C).
Typically 2 to 4% higher at high adjustment, full load.

SORENSEN
RAYTHEON
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

High Efficiency Switching Power Supplies
STM Series

- 18 models. 5V to 48V dc with power levels up to 672 watts
- 105-132V ac or 127-173V dc input
- Wide range output voltage adjustment
- Built-in adjustable overvoltage protection on all models
- Remote programming
- Remote sensing
- Adjustable Current Limiting
- Low ripple and noise
- 5 year warranty

The STM series offers all output voltages from 5V to 48V dc. Output voltage adjustment ranges on the STM offer a designer the flexibility to match a wide variety of load characteristics.

Specifications

INPUT

Voltage:
105-132V ac single phase or
127-173V dc

Frequency:
50-440 Hz operation without derating

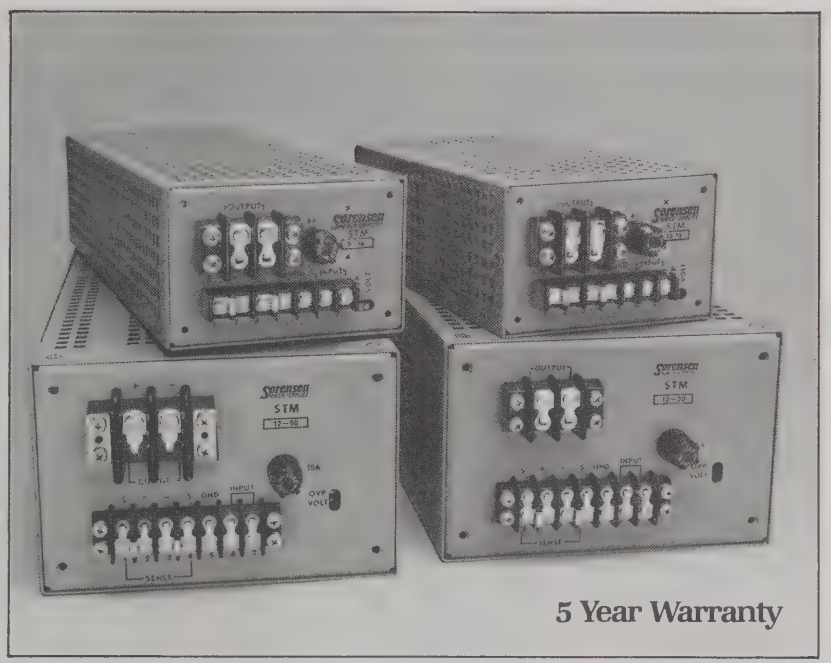
OUTPUT

Regulation:
Line: 0.025% + 1mV
Load: 0.025% + 1mV

Ripple:
Typical: 5mV rms, 30mV pk-pk
Maximum: 10mV rms, 50mV pk-pk

Temperature Coefficient:
0.01% maximum per°C

Stability:
0.05% for 24 hours after warm-up of 30 minutes.



5 Year Warranty

STM Series
Model Specifications

Transient Response Time:
Output voltage returns to within ±1% in less than 1ms following a step-load change for either 50% to 100% or 100% to 50% of full load.

Overshoot:
No overshoot on turn-on, turn-off or power failure.

Hold-up Time:
Full regulated voltage holds up for 15ms after removal of power at full load and nominal input and output voltages. (30ms for half load).

Overvoltage Protection:
Built-in, adjustable overvoltage protection standard on all models.

Current Limiting:
Automatic, internally adjustable.

OPERATING DATA

Efficiency:
64 to 78% depending on model.

Remote Sensing:
Terminals are provided on barrier strip. As long as terminal voltage does not exceed maximum output rating there are no basic limitations on load lead drop.

Remote Programming:
Resistance remote programming; 1000 ohm/volt
Voltage remote programming volt/volt

Series Operation:
200V dc maximum output.

Parallel Operation:
May be directly paralleled without derating.

Soft-Start:
In-rush current is limited by soft-start circuit.

Isolation:
1.3kV dc input to chassis.
300V dc ouput to chassis.

Ambient Operating Temperature Range:
0 to +70°C

Storage temperature Range:
-40 to +85°C

Cooling:
Convection cooled.

Finish:
Textured blue thermal paint.

Model	Nominal Output Voltage V dc	Output Voltage Adjustment V dc		Output Current A dc				Case
		Min.	Max.	40°C	50°C	60°C	70°C	
STM 5-24	5.0	4.5	6.0	24.0	19.4	14.9	9.6	III
STM 5-36	5.0	4.5	6.0	36.0	29.1	22.3	14.4	IIIA
STM 5-60	5.0	4.5	6.0	60.0	48.0	36.0	24.0	IVA
STM 5-100	5.0	4.5	6.0	100.0	80.0	60.0	40.0	VI
STM 12-12	12.0	9.5	13.5	12.0	9.7	7.5	4.8	III
STM 12-20	12.0	9.5	13.5	20.0	16.2	12.4	8.0	IIIA
STM 12-30	12.0	9.5	13.5	30.0	24.0	18.0	12.0	IVA
STM 12-50	12.0	9.5	13.5	50.0	40.0	30.0	20.0	VI
STM 15-24	15.0	13.0	17.0	24.0	19.2	14.4	9.6	IVA
STM 15-32	15.0	13.0	17.0	32.0	25.6	19.2	12.8	VI
STM 24-8.5	24.0	19.0	25.0	8.5	6.8	5.3	3.4	III
STM 24-21	24.0	19.0	25.0	21.0	16.8	12.6	8.4	IVA
STM 24-28	24.0	19.0	25.0	28.0	22.4	16.8	11.2	VI
STM 28-7	28.0	24.0	30.0	7.0	5.6	4.3	2.8	III
STM 28-11	28.0	24.0	30.0	11.0	8.9	6.8	4.4	IIIA
STM 28-24	28.0	24.0	30.0	24.0	19.2	14.4	9.6	VI
STM 48-10	48.0	42.0	56.0	10.0	8.0	6.0	4.0	IVA
STM 48-14	48.0	42.0	56.0	14.0	11.2	8.4	5.6	VI

Specifications subject to change without notice.

STM Series
Maximum Input Current

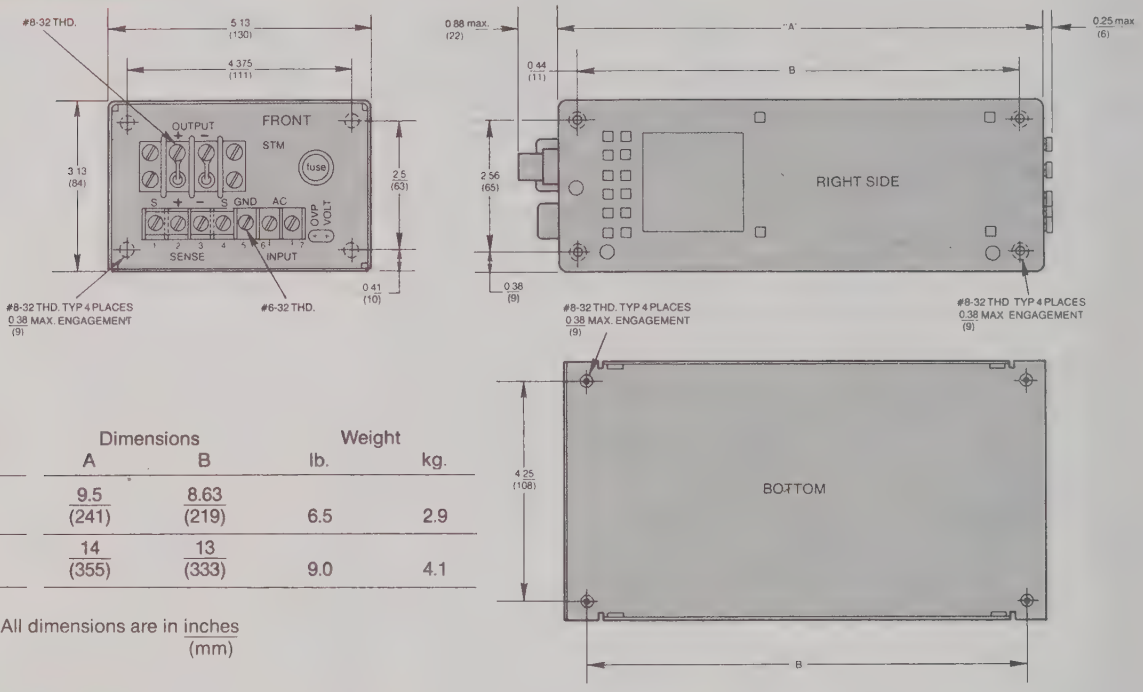
Nominal Input Voltage	Case III Amperes	Case IIIA Amperes	Case IVA Amperes	Case VI Amperes
115V ac	4.0	5.5	9.1	12.8
150V dc	1.9	3.2	4.8	6.7

Input Ratings, Typical Efficiency

Case III		Case IIIA		Case IVA		Case VI	
STM Model #	Efficiency %	STM Model #	Efficiency %	STM Model #	Efficiency %	STM Model #	Efficiency %
5-24	64	5-36	64	5-60	65	5-100	65
12-12	70	12-20	70	12-30	72	12-50	72
24-8.5	73	28-11	73	15-24	72	15-32	72
28-7	73			24-21	74	24-28	74
				48-10	78	28-24	76
						48-14	78

STM Series
Dimensional Drawings

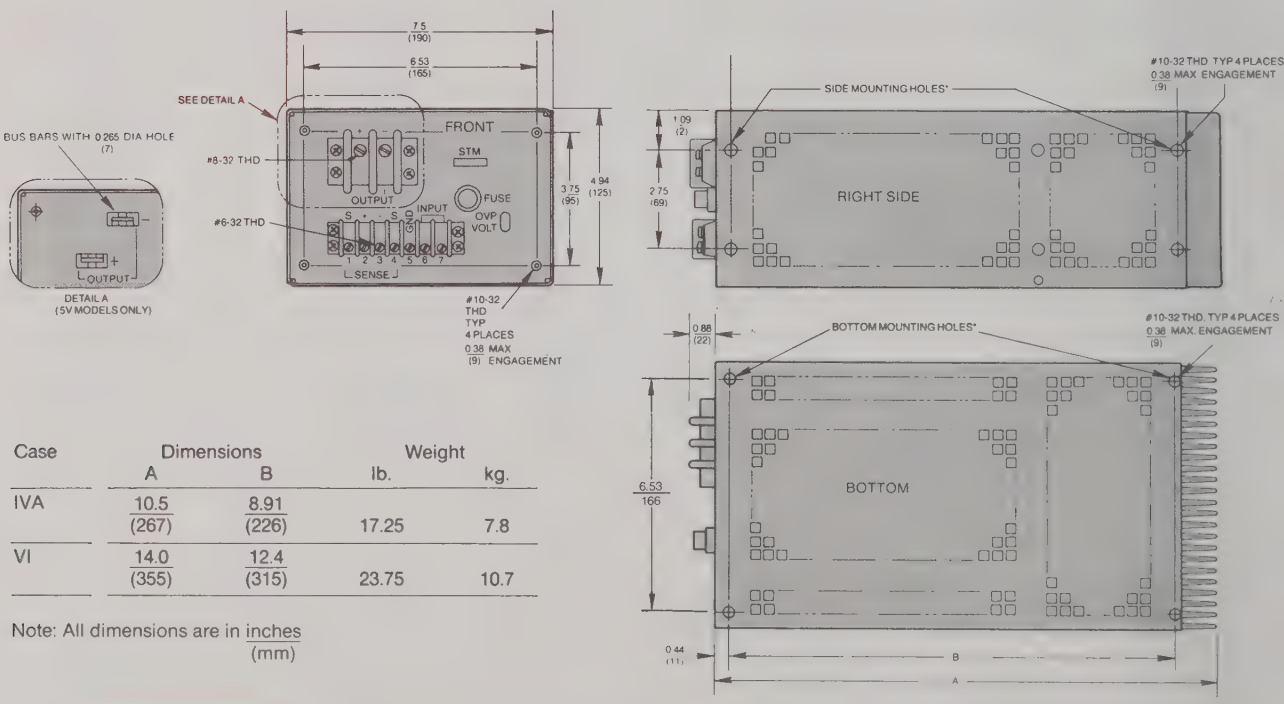
CASE III and IIIA



Case	Dimensions A	Dimensions B	Weight lb.	Weight kg.
III	9.5 (241)	8.63 (219)	6.5	2.9
IIIA	14 (355)	13 (333)	9.0	4.1

Note: All dimensions are in inches (mm)

CASE IVA and VI



Case	Dimensions A	Dimensions B	Weight lb.	Weight kg.
IVA	10.5 (267)	8.91 (226)	17.25	7.8
VI	14.0 (355)	12.4 (315)	23.75	10.7

Note: All dimensions are in inches (mm)

SORENSEN
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Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

Dual ac and dc Input Switching Power Supplies
SLC-B Series

- 30 single output models. 5V to 48V dc with power levels up to 300 watts
- 115V ac or 230V ac input
- Built-in overload and overvoltage protection
- High efficiency (up to 77%)
- Remote sensing
- Remote shutdown
- 2 year warranty

With up to 2 watts per cubic inch power density and two mounting surfaces, the SLC-B series is ideal for high density electronic package usage.

Specifications

INPUT

Voltage:
90-127V ac and 180-254V ac

Frequency:
47-440 Hz operation without derating

Start Up Time:
150ms (typical)

In-rush Current (typical)

30W/7A	150W/24A
55W/12A	200W/36A
100W/18A	300W/50A

OUTPUT

Regulation:
Line: 0.2% max. (0.1% for 300W models).
Load: 0.2% (max.): No load to full load
0.3% (max. 300W models): No load to full load.

Output Ripple and Noise (PARD):
50mV pk-pk maximum for 5V models.
100mV pk-pk maximum for 12-28V models.

Drift:
0.2% maximum over an 8 hour period after 30 minute warm up with constant line, load and ambient.

Temperature Coefficient:
±0.02%/°C
±0.01%/°C for 300W models.

Transient Response Time:
1.0ms typical (50% to 100% load) with maximum excursion of ± 3% up to 150W and ± 4% for 200W and above.

2 Year Warranty

DIMENSIONS:

DIM.	30W	55W	100W	150W	200W	300W
W	1.30	1.93	3.44	5.25	5.25	9.45
H	3.94	3.94	3.94	3.94	3.94	3.94
L	7.88	7.88	7.88	7.88	7.88	7.88
CASE NO.	1A	1B	2A	2B	3	4

SLC-B Series
Model Specifications

Overshoot:
No overshoot on turn-on, turn-off or power failure.

Remote Sensing:
Capable of maintaining nominal voltage at the load; compensating for a load-lead voltage drop of up to 10%.

Overload Protection:
Automatic Current Limiting (ACL) takes effect at 110-130% of maximum rated current and limits the output to a safe load.

Overvoltage Protection:
Overvoltage condition detected at 120-140% of nominal output voltage.

Dielectric Isolation:
Input/output, input/ground (case) 1,500V ac for one minute.
Output/ground (case) 500V dc for one minute.
Input/output, input/case, output/case 30 megohms.

Hold-up Time:
20ms typical for full load, nominal line (40ms for 300W models)

Electro Magnetic Interference:
SLC series meet FCC Class A and VDE 0871A level when used with the following Corcom filters:

Corcom Model 3EP3 suitable for use with 30, 55, 100 and 150 W models.

Corcom Model 6EP3 suitable for use with 200 and 300 W models.

Ambient Operating Temperature Range:
Full load rating from -10°C to 50°C. Derate per table.

Storage Temperature Range:
-25 to +85°C

Cooling:
Convection cooled.

Efficiency:

30W ...	63%	150W ...	74%
55W ...	71%	200W ...	75%
100W ...	73%	300W ...	77%

Finish:
Blue Thermal paint.

SLC-B SELECTION GUIDE AND PRICES

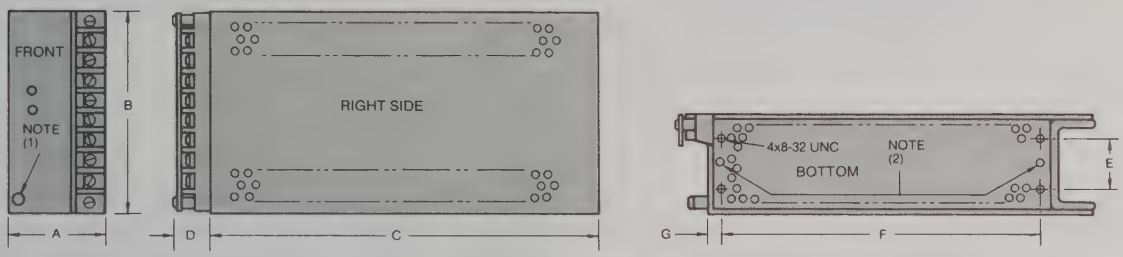
Current Output Maximum at 50°C Voltage ±10%						
5 Volt	**12 Volt**	**15 Volt**	**20 Volt**	**24 Volt**	**48 Volt**	**Price 1-9 Units**
SLC 5-6B 5 Vdc 6 A	SLC 12-2.5B 12 Vdc 2.5 A	SLC 15-2B 15 Vdc 2 A	SLC 20-1.5B 20 Vdc 1.5 A	SLC 24-1.2B 24 Vdc 1.2 A	–	$160.00 30 Watts
SLC 5-11B 5 Vdc 11 A	SLC 12-4.5B 12 Vdc 4.5 A	SLC 15-3.6B 15 Vdc 3.6 A	SLC 20-2.75B 20 Vdc 2.75 A	SLC 24-2.2B 24 Vdc 2.2 A	–	$180.00 55 Watts
SLC 5-20B 5 Vdc 20 A	SLC 12-8B 12 Vdc 8 A	SLC 15-6.6B 15 Vdc 6.6 A	SLC 20-5B 20 Vdc 5 A	SLC 24-4B 24 Vdc 4 A	–	$250.00 100 Watts
SLC 5-30B 5 Vdc 30 A	SLC 12-12B 12 Vdc 12 A	SLC 15-10B 15 Vdc 10 A	SLC 20-7.5B 20 Vdc 7.5 A	SLC 24-6B 24 Vdc 6 A	–	$300.00 150 Watts
SLC 5-40B 5 Vdc 40 A	SLC 12-16.6B 12 Vdc 16.6 A	SLC 15-13.3B 15 Vdc 13.3 A	SLC 20-10B 20 Vdc 10 A	SLC 24-8.3B 24 Vdc 8.3 A	SLC 48-4.1B 48 Vdc 4.1 A	$440.00 200 Watts
SLC 5-60B 5 Vdc 60 A	SLC 12-25B 12 Vdc 25 A	–	–	SLC 24-12.5B 24 Vdc 12.5 A	SLC 48-6.2B 48 Vdc 6.2 A	$695.00 300 Watts
Contact factory for non standard voltages.						

Prices and specifications subject to change without notice.

Maximum Input Current

CASE 1

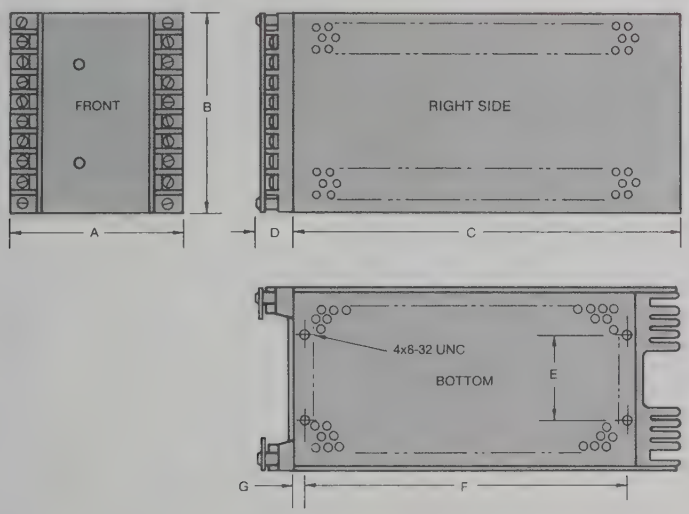
Nominal Input Voltage	Case 1A Amperes	Case 1B Amperes	Case 2A Amperes	Case 2B Amperes	Case 3 Amperes	Case 4 Amperes
115V ac	0.68	1.1	2.0	2.9	3.9	5.7
230V ac	0.34	0.55	1.0	1.5	2.0	2.9



Case	Weight		Dimensions A		B		C		D		E		F		G	
No.	lb.	kg.	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
1A	1.5	0.7	1.30	(33)	3.94	(100)	7.88	(200)	0.88	(22)	Note 2		6.69	(170)	0.16	(4)
1B	3.0	0.9	1.93	(49)	3.94	(100)	7.88	(200)	0.88	(22)	0.98	(25)	6.69	(170)	0.16	(4)

Note (1) Grounding lug on 30W and 55W models. Mounting holes located top and bottom.
Note (2) Two centered mounting holes located top and bottom of 30W models only.
All terminal screws are 6-32
Specifications subject to change without notice.

CASE 2

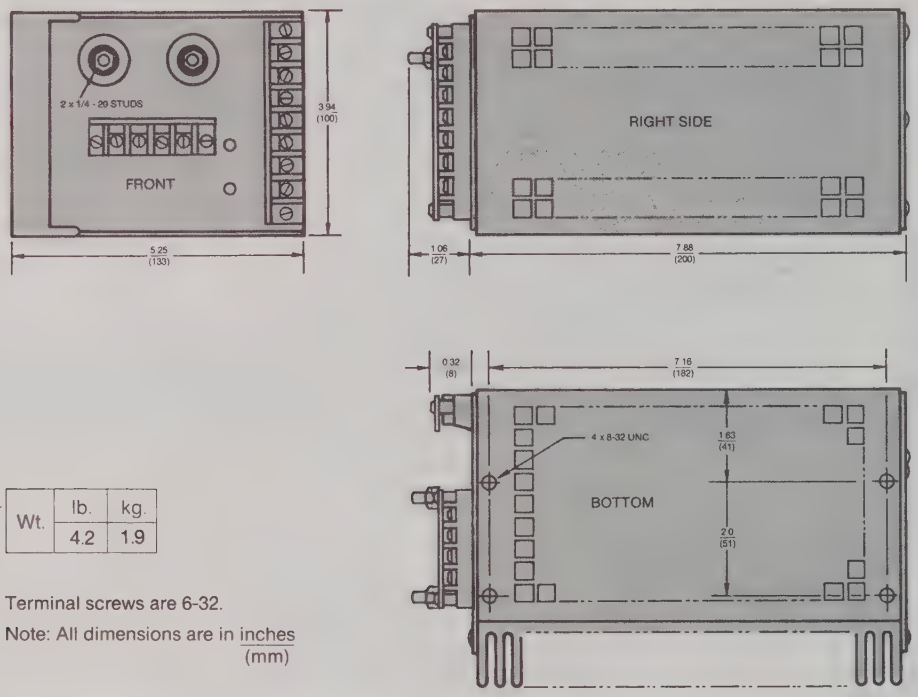


Case	Weight		Dimensions A		B		C		D		E		F		G	
No.	lb.	kg.	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
2A	3.0	1.4	3.44	(87)	3.94	(100)	7.88	(200)	0.88	(22)	1.65	(42)	6.69	(170)	0.16	(4)
2B	4.2	1.9	5.25	(133)	3.94	(100)	7.88	(200)	0.88	(22)	3.5	(89)	6.69	(170)	0.16	(4)

All terminal screws are 6-32

SLC-B Series
Dimensional Drawings

CASE 3

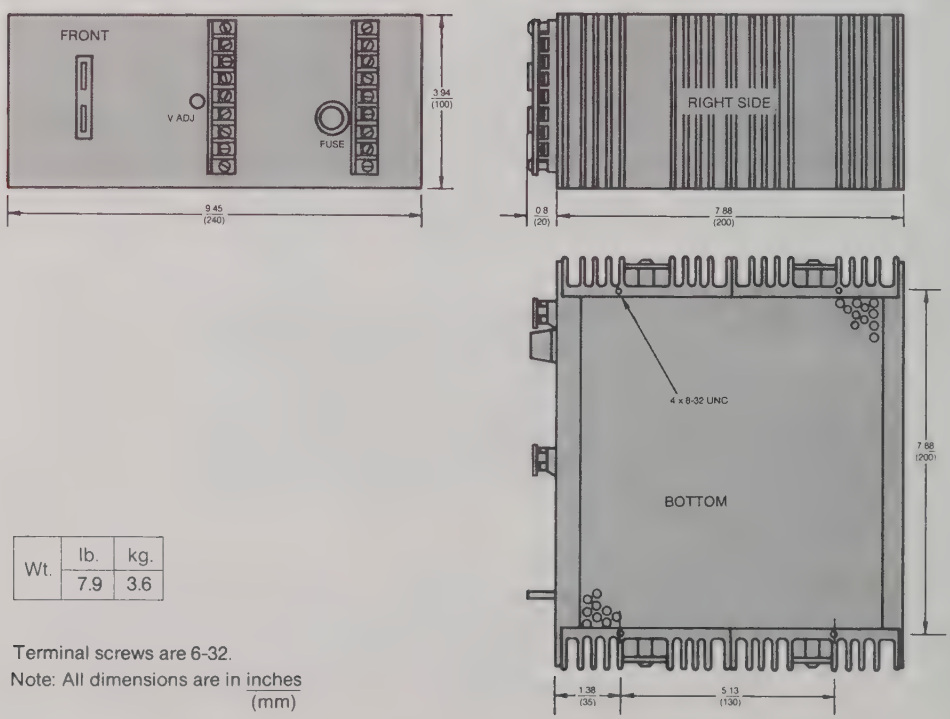


Wt.	lb.	kg.
	4.2	1.9

Terminal screws are 6-32.

Note: All dimensions are in inches (mm)

CASE 4



Wt.	lb.	kg.
	7.9	3.6

Terminal screws are 6-32.

Note: All dimensions are in inches (mm)

SORENSEN
RAYTHEON
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

SORENSEN

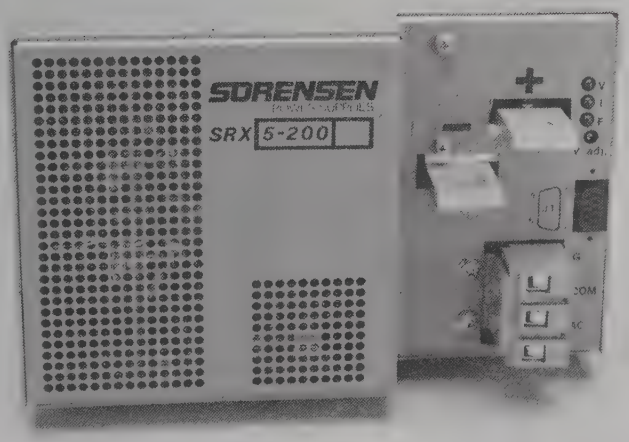
High Power Density Switching Power Supplies
SRX Series

- LED mode indicators
- Internal fan cooling
- High power density (2.47 watts per cubic inch)
- External crowbar drive
- High efficiency (75% typical)
- Remote sensing
- Overload protection
- Overvoltage protection
- Overtemperature protection
- AC failure flag
- Remote on/off control
- UL, CSA and VDE input connector
- Sturdy output busbar connection
- Industry standard case size
- U.L. listed, CSA certified
- 5 year warranty

The SRX produces 1/3 more output power than comparable units. It achieves high performance and reliability at a low unit watts cost.

Sorensen SRX 5-200 units are designed to meet the ever increasing power demands of computers, memories and large digital systems. Although housed in an industry standard package, the SRX produces 1/3 more output power than comparable units. The high power density coupled with high efficiency (75%) and flexible mounting arrangement makes the SRX unit ideal for use in any electronic product requiring high density packaging.

The SRX standard unit includes many features normally offered as optional, i.e., LED mode indicators, internal fan cooling and digital interfacing. An additional plus is the Sorensen 5 year warranty.



5 Year Warranty

SRX Series
Model 5-200 Specifications

INPUT
Voltage:
208/220/230V ac (190-250V ac)
Standard: Single phase, 47-63 Hz.
Optional: 115V ac (95-127V ac)
See next page.

OUTPUT
Voltage:
5.0V dc, adjustable range: 4.75 to 5.50V dc.

Current:
0 to 200A.

Regulation:
.1% maximum combined line and load variations within specified range.

Ripple and Noise:
15mV maximum rms ripple
50mV typical, 100mV maximum pk-pk ripple.

Efficiency:
75% typical.

Temperature Coefficient:
.015%/°C.

Long Term Stability:
±1% after 30 minute warm-up.

Hold Up Time:
40ms at nominal line and load.

Transient Response Time:
200μs maximum recovery to regulation bandwidth after a 50% step load change within 10 - 100% of full load. Maximum excursion ±4% and rate of step load; 2.5A per μs.

Overshoot:
Less than 1% overshoot on turn-on, turn-off or inhibit.

Remote Sensing:
Capable of maintaining regulation at the load, compensating for load-lead voltage drop of up to .25V.

AC Failure Flag
Logic low level flags ac power failure (14ms typical delay response). Flag sinks a maximum of 8mA and sources a minimum of .2mA.

On/Off Control:
Logic low level to inhibit.

Margin Check:
Open collector logic low level (0-.4V) on HI Margin to raise output 5% or on LO Margin to lower output 5%.

External Crowbar Drive:
100mA minimum drive for external SCR crowbar. Not furnished.

Overload Protection:
Automatic Current Limiting (ACL) adjustable from 0 to 110% of rated load. Foldback to approximately 70% under short-circuit.

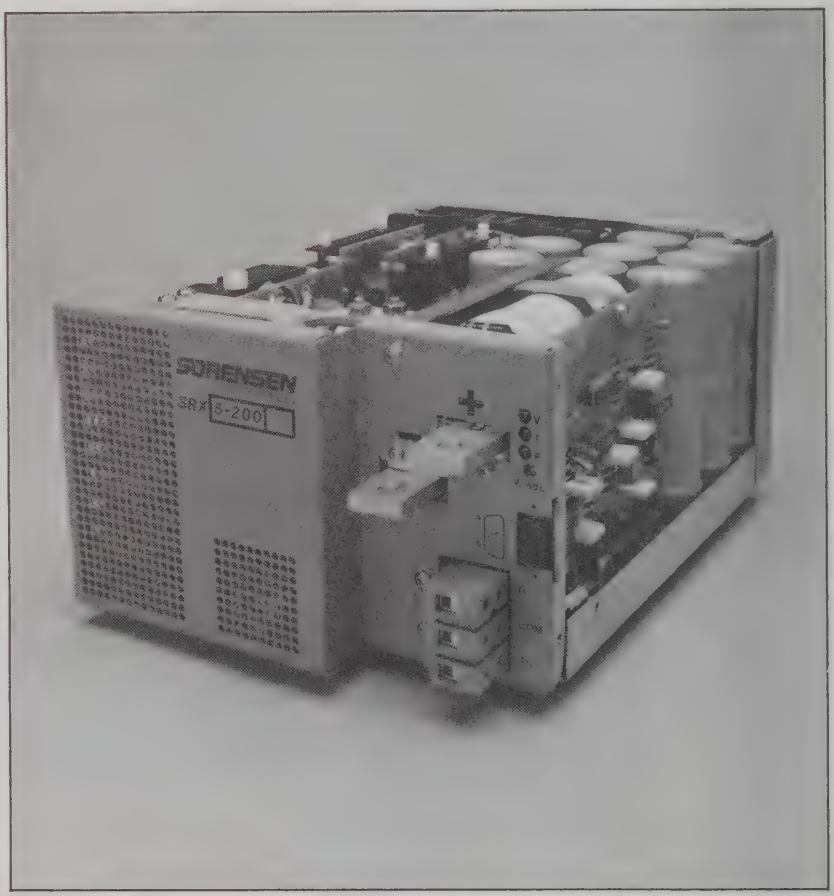
Overvoltage Protection:
Fixed OVP trip point within range of 6.5 to 7.0V dc.

Overtemperature Protection:
Automatic shut-down under overtemperature operation.

Low Line Protection:
Automatic shutdown under continuous low input voltage.

Ambient Operating Temperature Range:
Full load rating from 0 to 50°C. Derate to 60% at 70°C. (See Figure 1).

Storage Temperature Range:
-55 to +85°C



SORENSEN
RAYTHEON
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

Model 5-200 Specifications

Isolation:
2.1kV dc between input and output and case 500V dc between output and case.

EMI Suppression:
Filters are incorporated for the suppression of conducted EMI.

Power Density:
2.47 watts per cubic inch.

Cooling:
Fan cooled.

Outline Dimensions:
Industry standard case size 5"H x 8"W x 11"L.

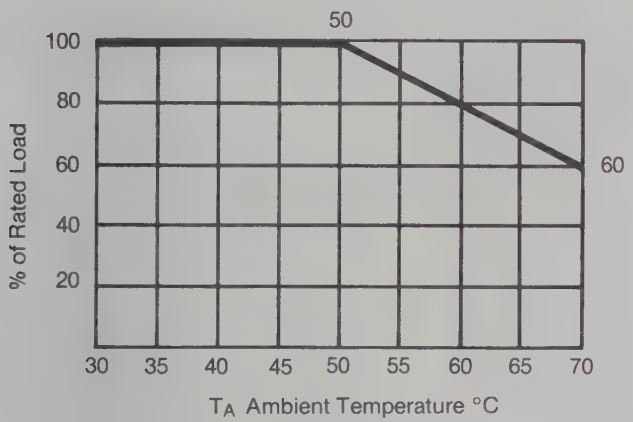
Mounting Dimensions:
Top and Bottom: 5.75" x 6.75"
Side: 4.00" x 6.75"
8-32 mounting screws, max. engagement .375"

Weight:
15 lbs.

Air Flow:
Standard Model intake from connector end and discharge at the opposite end. Reverse air flow optional feature (see below).

Input Connector:
Enclosed terminal strip (Weidmuller MK 6/3 4185.2). #10 AWG maximum.

Output Terminal:
Copper straps .25" thick x .875" wide, accepts 5/16" screw, maximum.



Power Derating Curve
(Figure 1)

Output Connector:
9 pin receptacle connector (AMP 207084-1).

Pin assignment:
1. AC Flag (return to -SEN)
2. +OUT
3. -Out
4. -SEN
5. +SEN
6. LO Margin (return to -SEN)
7. HI Margin (return to -SEN)
8. External crowbar drive (return to -Out)
9. Remote On/Off control (return to -SEN)

Finish:
Blue epoxy paint.

Optional Input Voltages and Air Flow
The standard unit, with 220V ac and standard air flow, is list priced.

Options:
115V ac, standard air flow; add suffix M1.

115V ac, reversed air flow; add suffix M2.

220V ac, reversed air flow; add suffix M3.

For voltage and air flow option add proper suffix to model number.
Example: SRX5-200M1

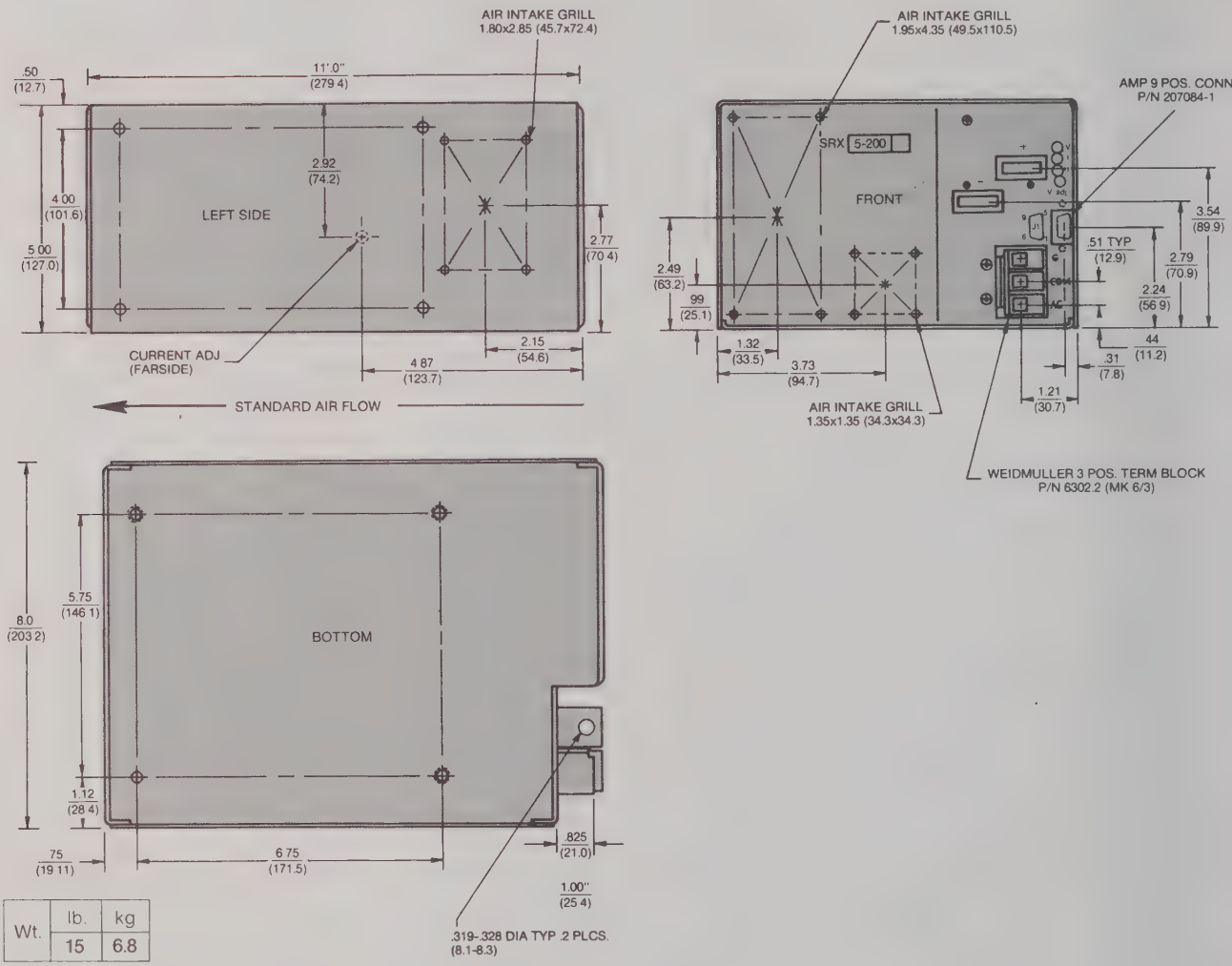
Specifications subject to change without notice.

Maximum Input Current

Nominal Input Voltage	Amperes
115V ac	20
230V ac	10

SRX Series
Dimensional Drawings

Model SRX 5-200



Wt.	lb.	kg
	15	6.8

Note: All dimensions are in inches (mm)

Note: Standard model shown. See preceding page for optional air flow information.

SORENSEN
RAYTHEON
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

Single and Dual Output Linear Power Supplies
PTM Series

SORENSEN

- 20 single output models in 5 voltage ranges from 5 to 28V dc with power levels up to 170 watts
- 5 dual output models from 0.8 to 3A
- 115/220/230V ac single phase input standard
- 49 to 440 Hz operation without derating
- High resolution output adjustments
- Adjustable overvoltage protection (OVP) on all models
- Adjustable Current Limiting
- Low ripple and noise
- Remote programming
- Remote sensing
- Dual outputs have one positive and one negative terminal with respect to a common terminal. Both individually adjustable
- U.L. listed
- 5 year warranty

The numerous input/output configurations available in the PTM series will enable you to easily incorporate standard units in your custom rack assemblies.

Specifications

INPUT

Voltage:
105-125V* ac single phase
200-240V ac single phase or
210-250V ac selectable by internal tap changes on power transformer.

Frequency:
49-440 Hz operation without derating.

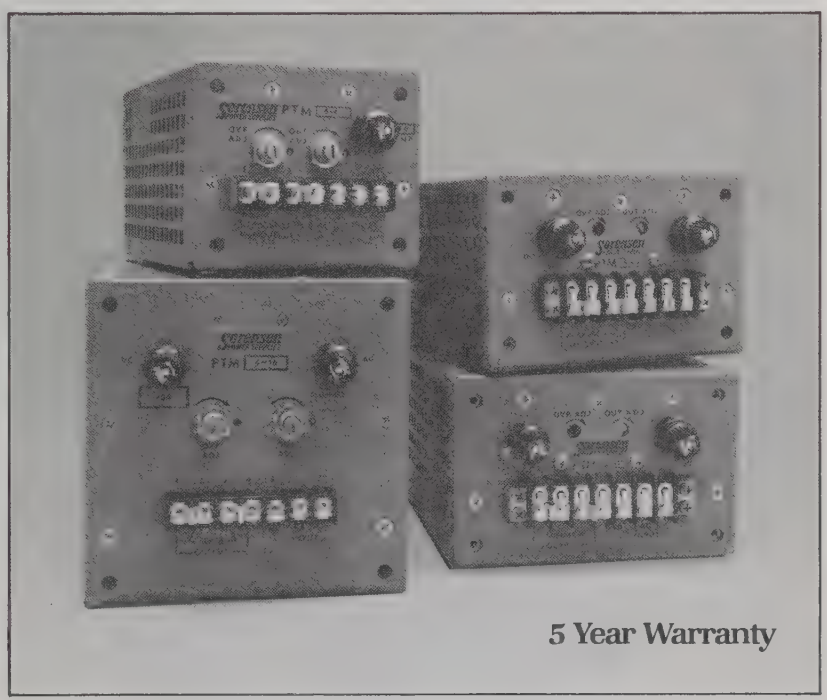
OUTPUT

Regulation:
Single output.
Line 0.02% + 1mV.
Load 0.03% + 4mV.
Dual output.
Line 0.01% +1mV.
Load 0.01% + 1mV.

Ripple:
1mV rms, 5mV pk-pk maximum.

Temperature Coefficient:
0.01%/°C or 1mV/°C, whichever is greater.

*132V ac at 20% reduced output current rating, reduce linearly from 125V ac.



5 Year Warranty

PTM Series
Model Specifications

Stability:
0.1% for 24 hours after 30 minute warm-up time.

Transient Response Time:
Output voltage returns to within ± 20mV band in less than 50 μs following a step-load change from 10% to 100% of full load.

Overshoot:
No overshoot at turn-on, turn-off or power failure.

Overvoltage Protection:
Automatic, adjustable crowbar action. Factory set to 120% of nominal output voltage.

Current Limiting:
Automatic fold-back type, internally adjustable 50% to 130% of rated current at 40°C. Factory set to 125%.

OPERATING DATA

Remote Sensing:
250mV maximum drop per load lead.

Remote programming:
Resistance programming: 500 ohms/V; voltage programming; volt/volt.

Isolation:
1.3kV dc input to chassis.
300V dc output to chassis.

Ambient Operating Temperature Range:
0 to + 70°C.

Storage Temperature Range:
-40° to +85°C.

Cooling:
Convection cooled.

Finish:
Textured blue thermal paint.

Single Output Models

Model	Nominal Output Voltage V dc	Output Voltage V dc Min.	Output Voltage V dc Max.	Output Current A dc 40°C	50°C	60°C	70°C	Case
PTM 5-4	5	4.8	5.5	4.0	3.6	2.8	1.6	I
PTM 5-7	5	4.8	5.5	7.0	6.3	4.9	2.8	II
PTM 5-11	5	4.8	5.5	11.0	9.6	7.8	4.4	III
PTM 5-16	5	4.8	5.5	16.0	14.0	11.0	6.5	IIIB
PTM 12-2.7	12	11.4	12.6	2.7	2.4	1.9	1.1	I
PTM 12-4.4	12	11.4	12.6	4.4	4.0	3.1	1.8	II
PTM 12-6.5	12	11.4	12.6	6.5	5.7	4.6	2.7	III
PTM 12-10.5	12	11.4	12.6	10.5	9.5	7.0	4.0	IIIB
PTM 15-2.4	15	14.25	15.75	2.4	2.1	1.7	0.95	I
PTM 15-3.5	15	14.25	15.75	3.5	3.1	2.5	1.6	II
PTM 15-5.5	15	14.25	15.75	5.5	4.9	3.9	2.5	III
PTM 15-9.5	15	14.25	15.75	9.5	8.5	6.5	3.6	IIIB
PTM 24-1.6	24	23.0	25.0	1.6	1.4	1.1	0.65	I
PTM 24-2.3	24	23.0	25.0	2.3	2.1	1.7	1.1	II
PTM 24-4	24	23.0	25.0	4.0	3.6	2.9	1.9	III
PTM 24-6.8	24	23.0	25.0	6.8	6.0	4.5	2.7	IIIB
PTM 28-1.4	28	27.0	29.0	1.4	1.2	1.0	0.55	I
PTM 28-2	28	27.0	29.0	2.0	1.8	1.5	1.00	II
PTM 28-3.5	28	27.0	29.0	3.5	3.1	2.6	1.8	III
PTM 28-6.0	28	27.0	29.0	6.0	5.5	4.0	2.4	IIIB

Specifications subject to change without notice.

Dual Output Models

PTM 12/1D	±12	±11	±13	1.0	0.90	0.70	0.40	I
PTM 12/3D	±12	±11	±13	3.0	2.70	2.10	1.20	III
PTM 15/.8D	±15	±14	±16	0.8	0.72	0.56	0.32	I
PTM 15/1.5D	±15	±14	±16	1.5	1.35	1.05	0.60	II
PTM 15/2.8D	±15	±14	±16	2.8	2.52	1.96	1.12	III

Specifications subject to change without notice.

Maximum Input Current

Single Output Models

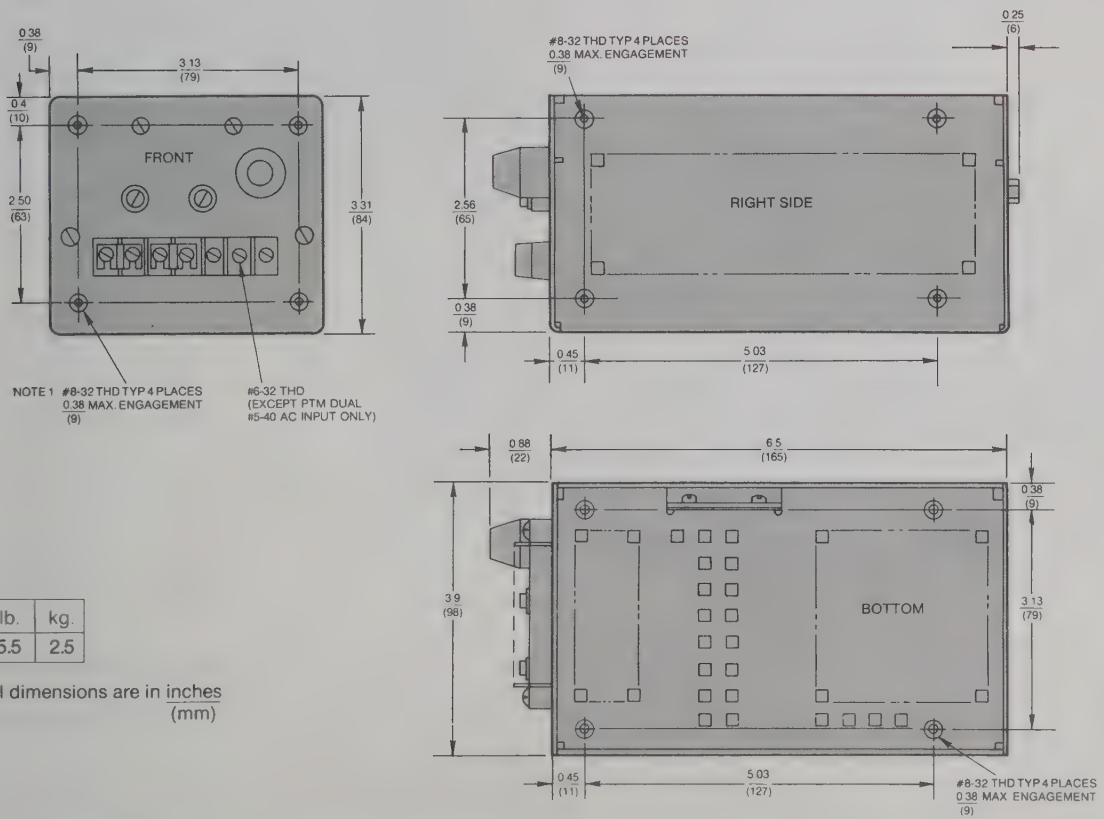
Nominal Input Voltage	Case I Amperes	Case II Amperes	Case III Amperes	Case IIIB Amperes
115V ac	0.8	1.3	2.4	3.0
220V ac	0.42	0.68	1.3	1.6
230V ac	0.40	0.65	1.2	1.5

Dual Output Models

Nominal Input Voltage	Case I Amperes	Case II Amperes	Case III Amperes
115V ac	0.6	0.9	1.8
220V ac	0.35	0.48	0.96
230V ac	0.3	0.45	0.90

Note: Units shipped are wired for nominal 115V ac.

CASE I

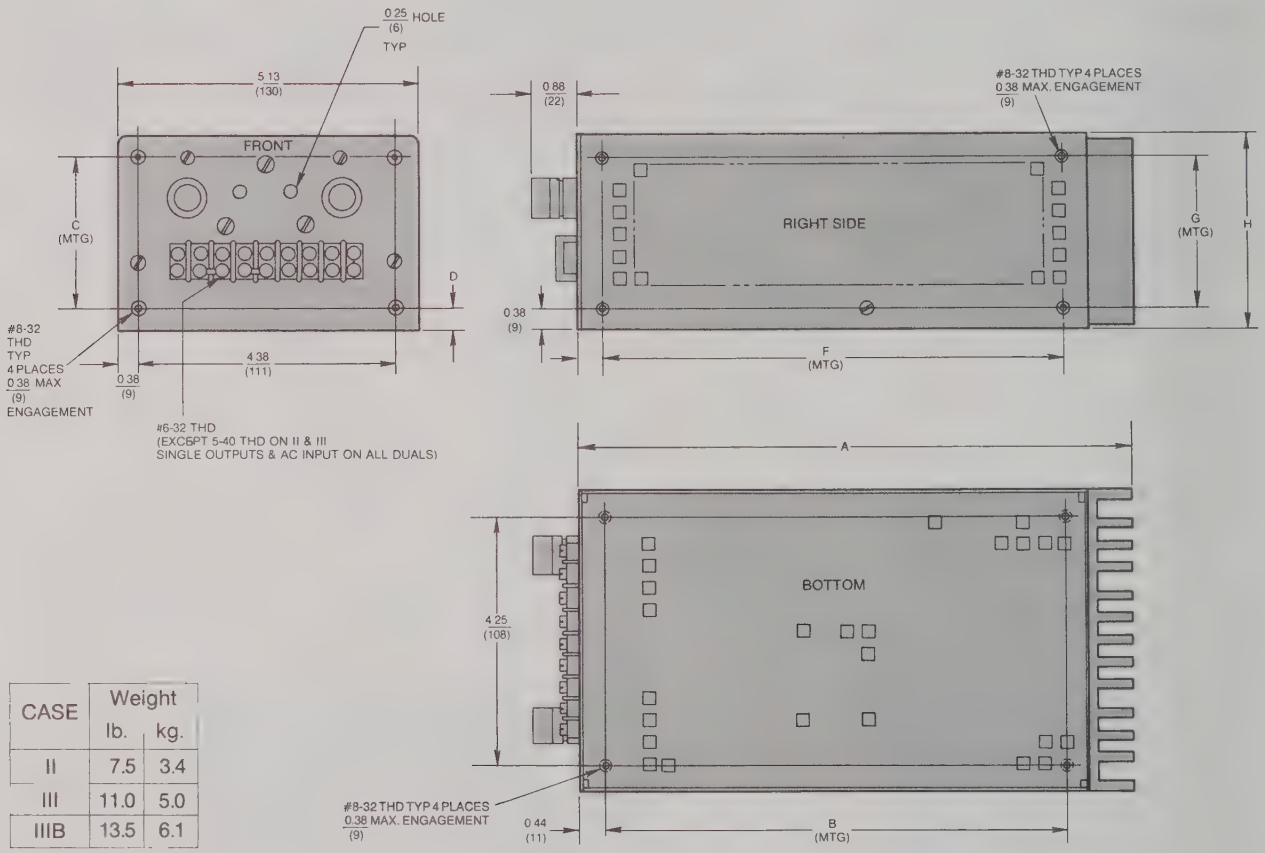


Wt.	lb.	kg.
	5.5	2.5

Note: All dimensions are in inches (mm)

PTM Series
Dimensional Drawings

CASE II, III and IIIB



CASE	Weight	
	lb.	kg.
II	7.5	3.4
III	11.0	5.0
IIIB	13.5	6.1

Case	Dimensions							
	A	B	C	D	E	F	G	H
II	6.5 (165)	5.03 (128)	2.5 (63)	0.46 (12)	0.45 (11)	5.03 (128)	2.56 (65)	3.3 (84)
III	9.5 (241)	7.88 (200)	2.5 (63)	0.46 (12)	0.44 (11)	7.88 (200)	2.56 (65)	3.3 (84)
IIIB	9.5 (241)	7.88 (200)	4.38 (111)	0.38 (9)	0.44 (11)	7.88 (200)	4.38 (111)	5.13 (130)

Note: All dimensions are in inches (mm)

SORENSEN RAYTHEON Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

SORENSEN

Wide Range, Adjustable Output Linear Power Supplies
QSA Series

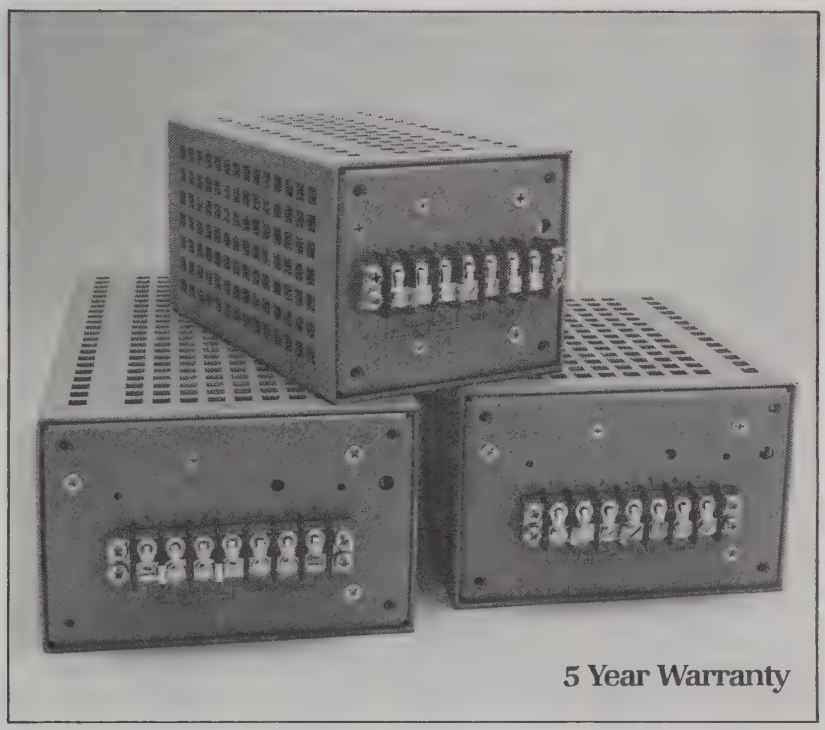
- 12 models, 0-10V to 200-330V dc with power levels up to 58 watts
- 115/220/230V ac input standard
- 47-440 Hz, operation without derating
- Excellent Regulation
- Low noise and ripple, 300μV rms maximum
- Wide range, adjustable output
- No overshoot on turn-on, turn-off, or power failure
- Remote programming
- Remote sensing
- Master/slave operation
- Convection cooled
- U.L. listed
- 5 year warranty

The high performance capabilities of QSA units have been proven through years of trouble free operation.

With a wide range adjustable output, models are available from 0-10V dc to 200-330V dc.

Remote programming, remote sensing, adjustable current limiting are all standard features.

Standard off-the-shelf models can be easily incorporated in custom power assemblies (rack assemblies) to meet your specific output voltage requirements.



5 Year Warranty

QSA Series
Model Specifications

INPUT

Voltage:
105-125V ac single phase
200-240V ac single phase or
210-250V ac selectable by changing taps on power transformer.

Frequency:
47-440 Hz operation without derating.

OUTPUT

Regulation:
10V models
Line 0.006% + 0.2mV.
Load 0.004% + 0.2mV.
18V-265V models
Line 0.012%
Load 0.008%

Temperature Coefficient:
0.015% or 0.5mV/°C

Ripple:
300μV rms, 3mV pk-pk max.

Stability:
0.025% + 1mV for 8 hours after 30 mins. warm-up time.

Transient Response Time:
Output voltage returns to within ± 20mV band in 20μs (typical) following a step-load change of 0% to 100% of full load.

Overshoot:
No overshoot at turn-on, turn-off or power failure.

Overvoltage Protection:
Available option. See Table below.

Current Limiting:
Automatic current fold-back type, internally adjustable from 65% to 125% of full-rated load current at 40°C. Factory set to 135%.

OPERATING DATA

Remote Sensing:
1.5V maximum drop per load lead.

Remote programming:
Resistance programming:
10V models - 100 ohm/v
18-120V models - 40 ohms/v
175-265V models - 90 ohms/v
Voltage programming, volt/volt.

Series Operation:
Two units in series, except 10V models which may be operated up to 100V dc total output.

Parallel Operation:
Up to four units may be operated in parallel in a master-slave configuration.

Isolation:
Input to chassis: 1.3kV dc.
Output to chassis:
200V dc (10-18V models).
600V dc (48V model).
900V dc (75-120V models).
990V dc (175-265V models).

Ambient Operating Temperature Range:
0 to + 70°C.

Storage Temperature Range:
-40° to +85°C.

Cooling:
Convection cooled.

Finish:
Textured blue thermal paint.

Model	Output Range V dc	Output Current A dc 40°C	50°C	60°C	70°C	Optional Overvoltage (See section 5 for details) Case	OVP
QSA 10-1.4	0-10	1.5	1.4	1.2	0.9	I	VP1
QSA 10-3.7	0-10	4.0	3.7	3.1	2.5	III	VP1
QSA 18-1.1	14-22	1.2	1.1	0.9	0.7	I	VP1
QSA 18-1.9	14-22	2.1	1.9	1.6	1.3	II	VP1
QSA 18-3.0	14-22	3.3	3.0	2.5	2.0	III	VP1
QSA 48-0.4	35-60	0.44	0.4	0.34	0.27	I	VP3
QSA 48-0.8	35-60	0.88	0.8	0.68	0.57	II	VP3
QSA 48-1.2	35-60	1.3	1.2	1.0	0.8	III	VP3
QSA 75-0.5	60-90	0.55	0.5	0.42	0.33	II	VP3
QSA 120-0.5	90-150	0.55	0.5	0.42	0.33	III	VP8
QSA 175-0.25	150-200	0.28	0.25	0.21	0.17	III	VP23
QSA 265-0.15	200-330	0.17	0.15	0.13	0.10	III	VP23

Specifications subject to change without notice.

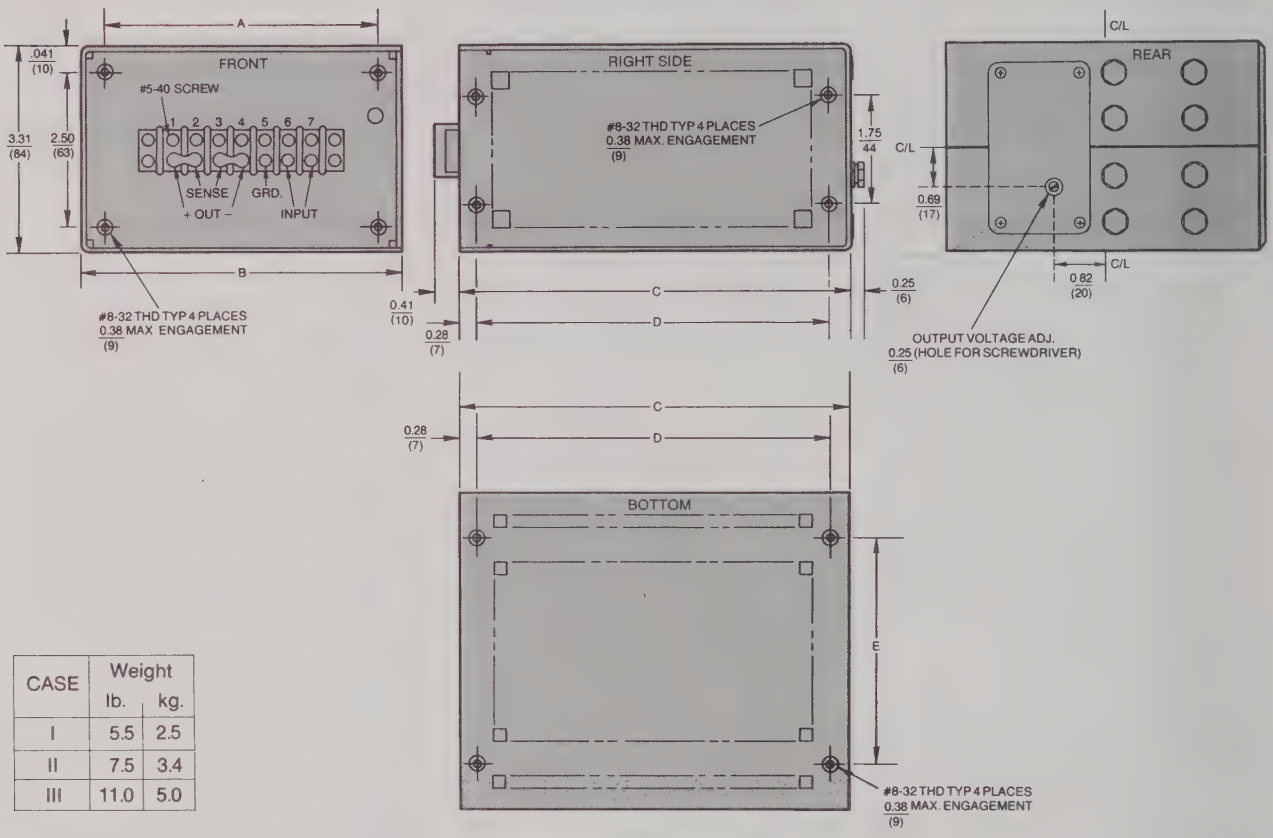
QSA Series
Maximum Input Current

Model	Case	Input Current, Maximum Amperes, ac		
		115V ac	220V ac	230V ac
QSA 10-1.4	I	.6	.3	.3
QSA 10-3.7	III	1.4	.7	.7
QSA 18-1.1	I	.8	.4	.4
QSA 18-1.9	II	1.3	.65	.65
QSA 18-3.0	III	1.8	.9	.9
QSA 48-0.4	I	.7	.35	.35
QSA 48-0.8	II	1.3	.65	.65
QSA 48-1.2	III	1.8	.9	.9
QSA 75-0.5	II	1.2	.6	.6
QSA 120-0.5	III	1.8	.9	.9
QSA 175-0.25	III	1.2	.6	.6
QSA 265-0.15	III	1.3	.65	.65

Note: Units shipped are wired for nominal 115V ac.

QSA Series
Dimensional Drawings

CASE I, II and III



CASE	Weight	
	lb.	kg.
I	5.5	2.5
II	7.5	3.4
III	11.0	5.0

Case	Dimensions				
	A	B	C	D	E
I	3.13 (79)	3.88 (98)	6.31 (160)	5.69 (144)	2.38 (60)
II	4.38 (111)	5.13 (130)	6.31 (160)	5.69 (144)	3.63 (92)
III	4.38 (111)	5.13 (130)	9.31 (236)	8.69 (220)	3.63 (92)

Note: All dimensions are in inches (mm)

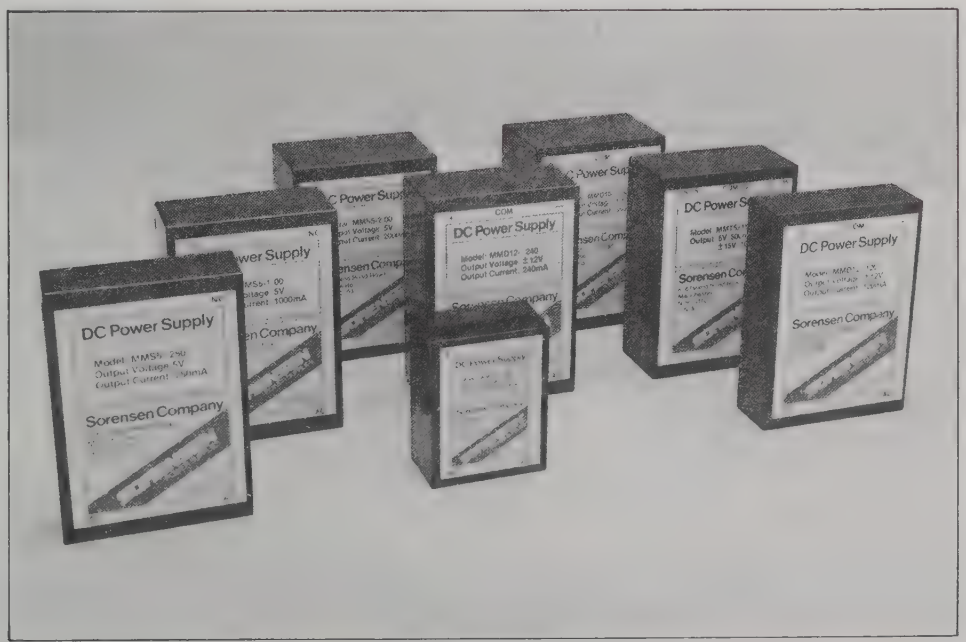
SORENSEN
RAYTHEON

Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

Miniature Encapsulated Linear Power Supplies
KM, LM, NM, DL, DM Series

The convenience of terminal strip connections and threaded insert mounting make the DL and DM series ideal for prototype design or low volume production applications.

The KM, LM, NM series of power supplies, in single, dual and triple output configurations, are ideal for powering OP amps, linear IC and discrete analog or MOS circuits.



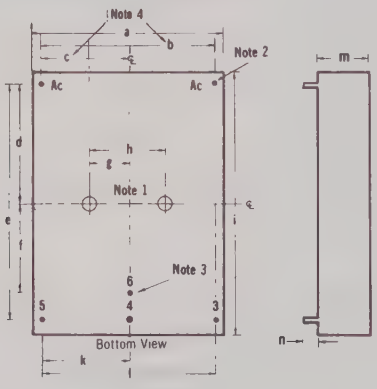
NMS Single Outputs - PC Mount

Voltage	Current	Case Config.	SORENSEN P/N
5	250 ma	B	NMS 5-.250
5	500 ma	B	NMS 5-.500
5	1000 ma	A	NMS 5- 1.00
5	2000 ma	C	NMS 5- 2.00
6	450 ma	B	NMS 6- .450
6	900 ma	A	NMS 6- .900
8	350 ma	B	NMS 8- .350
8	700 ma	A	NMS 8- .700
10	250 ma	B	NMS 10- .250
10	500 ma	A	NMS 10- .500
12	250 ma	B	NMS 12- .250
12	500 ma	A	NMS 12- .500
15	200 ma	B	NMS 15- .200
15	500 ma	A	NMS 15- .500
18	100 ma	B	NMS 18- .100
18	200 ma	A	NMS 18- .200
20	100 ma	B	NMS 20- .100
20	200 ma	A	NMS 20- .200
24	100 ma	B	NMS 24- .100
24	200 ma	A	NMS 24- .200
28	100 ma	B	NMS 28- .100
28	200 ma	A	NMS 28- .200

NMD Dual Output - PC Mount

Voltage	Current	Case Config.	SORENSEN P/N
± 12	± 30 ma	B	NMD 12- .030
± 12	± 50 ma	B	NMD 12- .050
± 12	± 120 ma	B	NMD 12- .120
± 12	± 240 ma	A	NMD 12- .240
± 12	± 300 ma	C	NMD 12- .300
± 12	± 400 ma	C	NMD 12- .400
± 15	± 30 ma	B	NMD 15- .030
± 15	± 65 ma	B	NMD 15- .065
± 15	± 100 ma	B	NMD 15- .100
± 15	± 200 ma	A	NMD 15- .200 *
± 15	± 350 ma	C	NMD 15- .350
± 18	± 30 ma	B	NMD 18- .030
± 18	± 50 ma	B	NMD 18- .050
± 18	± 100 ma	A	NMD 18- .100 *
± 18	± 200 ma	A	NMD 18- .200
± 20	± 80 ma	B	NMD 20- .080
± 20	± 200 ma	A	NMD 20- .200
± 24	± 50 ma	B	NMD 24- .050
± 24	± 100 ma	A	NMD 24- .100
± 28	± 200 ma	C	NMD 28- .200

DIMENSIONS



CONNECTIONS

Single Outputs -
Pin 3 No Connect
4 - Vdc Out
5 + Vdc Out
6 Faraday Shield*
*M6 Option Only

Dual Outputs -
Pin 3 - Vdc Out
4 Common Out
5 + Vdc Out
6 Faraday Shield*

OPTIONS

M2 200 - 252 VAC Input
M3 105 - 125/210 - 250 VAC Input
M5 Terminals
M6 Faraday Shield
M7 Overvoltage Protection

* UL Recognized. Consult factory for complete listing.

Notes:
1. 4-40 insert .125 (3) Deep Min.
2. All Pins .040 Diameter
3. Pin 6 provided only on M6 option models.
4. Optional pin spacing available at no charge. See columns a, i, and m below for package outlines.

	a	b	c	d	e	f	g	h	i	j	k	l	m	n
A in(mm)	2.5(64)	2.2(56)	1.1 (28)	1.6(40.6)	3.2(81)	1.1(28)	.5(12.5)	1.0(25.4)	3.5(89)		1.1(28)	2.2(56)	1.25(32)	.25(6.3)
B in(mm)	2.5(64)	2.2(56)	1.1 (28)	1.6(40.6)	3.2(81)	1.1(28)	.5(12.5)	1.0(25.4)	3.5(89)		1.1(28)	2.2(56)	.88(22)	.25(6.3)
C in(mm)	2.5(64)	2.2(56)	1.1 (28)	1.6(40.6)	3.2(81)	1.1(28)	.5(12.5)	1.0(25.4)	3.5(89)		1.1(28)	2.2(56)	1.59(51)	.25(6.3)

GENERAL SPECIFICATIONS

Electrical

Input: 105 to 125Vac, 50 hz to 440 hz std.
Output Voltage Set Accuracy: ± .5%
Load Regulation: 0.1% of V out (no load to full load)
Line Regulation: 0.05% of V out (low line to high line)
Ripple: 1 mV P-P max
Transient Response: 1 mV P-P for less than 1 usec.
Temperature Coefficient: .02%/°C
Isolation Resistance Input to Output: Greater than 500 megohms.
Hi Pot Input To Output: 1750 Vrms (2500 Vdc)
Current Foldback/Short Circuit Prot.: (Standard all models).

Environmental

Operating: — 25°C to + 70°C ambient
Storage: — 40°C to + 85°C

Mechanical

Case: Bakelite/Diallylphthalate, Black
Encapsulation: Epoxy
Mounting: Two 4-40 Inserts (PC mount)
Four 4-40 Inserts (Chassis mount)

Connections

1. P.C. Pins, .250 Long Min.
2. Terminal Blocks, only on chassis mount units

WARRANTY:
Raytheon warrants all parts of equipment of its manufacture, except special purpose tubes and semiconductor devices which carry their own manufacturer's warranty, to be free from defects caused by faulty material or poor workmanship. Raytheon warrants its products to conform to applicable commercial or military specifications when confirmed on the Order Acknowledgement form to be free from defects caused by faulty material or poor workmanship. Raytheon's obligation is limited under the warranty to repair or replacement of products in kind, or at its sole option to issuance of a credit of original purchase price. Returns must be accompanied by a Raytheon Return Authorization form and conform to standard conditions of adjustment. The aforesaid warranty shall expire 36 months following the last day of the month of shipment from Raytheon's plant. The foregoing states the entire warranty extended by Raytheon. No other warranty, expressed or implied, is made, and specifically, Raytheon makes no warranty of merchantability or fitness for any purpose. In no case shall Raytheon be liable for any special or consequential damages. Authorization must be obtained prior to return of defective items.

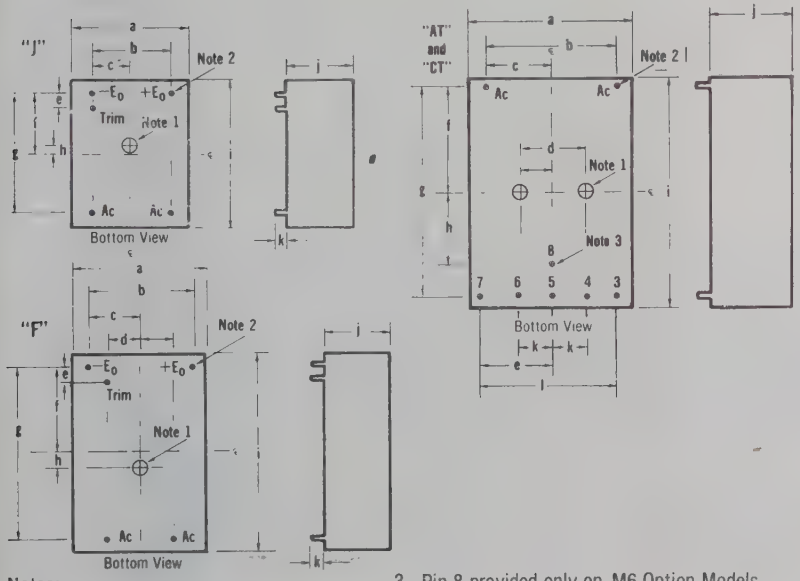
Microminiature - PC Mount

Voltage	Current	Case Config.	SORENSEN P/N
3.6	250 ma	F	KMS 3.6 -.250
5	250 ma	F	KMS 5 - .250
6	200 ma	F	KMS 6 - .200
10	120 ma	J	KMS 10 - .120
12	100 ma	J	KMS 12 - .100
15	100 ma	J	KMS 15 - .100
18	65 ma	J	KMS 18 - .065
20	60 ma	J	KMS 20 - .060
24	50 ma	J	KMS 24 - .050
28	40 ma	J	KMS 28 - .040

Triple Output - PC Mount

Voltage	Current	Case Config.	SORENSEN P/N
± 12 + 5	± 100 + 250 ma	AT	LMT 250/100
± 12, + 5	± 100, + 500 ma	AT	LMT 500/100
± 12, + 5	± 150, + 300 ma	AT	LMT 300/150
± 12, + 5	± 150, + 500 ma	AT	LMT 500/150
± 12, + 5	± 180, + 300 ma	AT	LMT 300/180
± 15, + 5	± 100, + 250 ma	AT	NMT 250/100
± 15, + 5	± 100, + 500 ma	AT	NMT 500/100
± 15, + 5	± 150, + 300 ma	AT	NMT 300/150
± 12, + 5	± 100, + 750 ma	CT	LMT 750/100
± 12, + 5	± 100, + 1000 ma	CT	LMT 1000/100
± 12, + 5	± 150, + 1000 ma	CT	LMT 1000/150
± 15, + 5	± 100, + 750 ma	CT	NMT 750/100
± 15, + 5	± 100, + 1000 ma	CT	NMT 1000/100
± 15, + 5	± 150, + 1000 ma	CT	NMT 1000/150

DIMENSIONS



Notes:

1. 4-40 Insert .125 (3) Deep Min.
2. All Pins .040 (1) Diameter, .25 lg.
3. Pin 8 provided only on M6 Option Models.
4. Optional pin spacing available at no charge.

See columns a, i and j below for package on line.

CONNECTIONS

Triple Output-Standard:
Pin 3 - 12/- 15 Vdc Out
4 + 5 Vdc Return
5 Common Out
6 + 5 Vdc Out
7 + 12/+ 15 Vdc Out
8 Faraday Shield **

** M6 Option Only
Microminiature
(See drawings for connections)
For + 5% trim adjust:

OPTIONS

M2 200 - 252 VAC Input
M3 105-125/210-250 VAC Input
M5 Terminals
M6 Faraday Shield
M7 Overvoltage Protection

	a	b	c	d	e	f	g	h	i	j	k	l
J in(mm)	1.75 (44.4)	1.20(30.5)	.60 (15.2)		.20 (5)	.92 (23.5)	1.8 (45.7)	.125 (3)	2.25 (57)	1.00 (25.4)	.25 (6.3)	
F in(mm)	2.00 (51)	1.60 (40.6)	.80 (20.3)	.50 (12.7)	.20 (5)	1.30 (33)	2.60 (66)	.25 (6.3)	3.00 (76.2)	1.00 (25.4)	.25 (6.3)	
AT in(mm)	2.5 (64)	2.2 (56)	1.1 (28)	1.0 (25.5)	1.1 (28)	1.6 (40.6)	3.2 (81)	1.1 (28)	3.5 (89)	1.25 (32)	.50 (13)	2.2 (56)
CT in(mm)	2.5 (64)	2.2 (56)	1.1 (28)	1.0 (25.5)	1.1 (28)	1.6 (40.6)	3.2 (81)	1.1 (28)	3.5 (89)	1.59 (51)	.50 (13)	2.2 (56)

GENERAL SPECIFICATIONS

Electrical

Input: 105 to 125Vac, 50 hz to 440 hz std.
Output Voltage Set Accuracy: ± .5%
Load Regulation: 0.1% of V out (no load to full load)
Line Regulation: 0.05% of V out (low line to high line)
Ripple: 1 mV P-P max
Transient Response: 1 mV P-P for less than 1 usec.
Temperature Coefficient: .02%/°C
Isolation Resistance Input to Output: Greater than 500 megohms.
Hi Pot Input To Output: 1750 Vrms (2500 Vdc)
Current Foldback/Short Circuit Prot.: (Standard all models).

Environmental

Operating: — 25°C to + 70°C ambient
Storage: — 40°C to + 85°C

Mechanical

Case: Bakelite/Diallylphthalate, Black
Encapsulation: Epoxy
Mounting: Two 4-40 Inserts (PC mount)
Four 4-40 Inserts (Chassis mount)

Connections

1. P.C. Pins, .250 Long Min
2. Terminal Blocks, only on chassis mount units

WARRANTY

Raytheon warrants all parts of equipment of its manufacture except special purpose tubes and semiconductor devices which carry their own manufacturer s warranty to be free from defects caused by faulty material or poor workmanship. Raytheon warrants its products to conform to applicable commercial or military specifications when confirmed on the Order Acknowledgement form to be free from defects caused by faulty material or poor workmanship. Raytheon s obligation is limited under the warranty to repair or replacement of products in kind, or at its sole option to issuance of a credit of original purchase price. Returns must be accompanied by a Raytheon Return Authorization form and conform to standard conditions of adjustment. The aforesaid warranty shall expire 36 months following the last day of the month of shipment from Raytheon s plant. The foregoing states the entire warranty extended by Raytheon. No other warranty, expressed or implied, is made, and specifically, Raytheon makes no warranty of merchantability or fitness for any purpose. In no case shall Raytheon be liable for any special or consequential damages. Authorization must be obtained prior to return of defective items.

SORENSEN

3 Year Warranty

Single Output - Chassis Mount

Voltage	Current	Case Config.	SORENSEN P/N
5	500 ma	E	DMS 5 - .500
5	1000 ma	E	DMS 5- 1.00
5	2000 ma	D	DMS 5- 2.00
5	3000 ma	D	DMS 5- 3.00

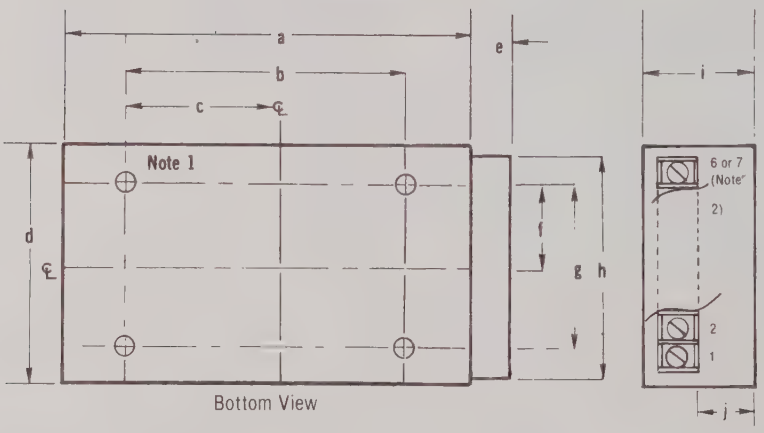
Dual Output - Chassis Mount

Voltage	Current	Case Config.	SORENSEN P/N
± 12	± 120 ma	E	DMD 12- .120
± 12	± 240 ma	E	DMD 12- .240
± 12	± 400 ma	D	DMD 12- .400
± 15	± 100 ma	E	DMD 15- .100
± 15	± 200 ma	E	DMD 15- .200
± 15	± 350 ma	D	DMD 15- .350
± 15	± 500 ma	D	DMD 15- .500

Triple Output - Chassis Mount

Voltage	Current	Case Config.	SORENSEN P/N
± 12, + 5	± 120, + 500	E	DMT 500/120
± 12, + 5	± 200, + 300	E	DMT 300/200
± 12, + 5	± 150, + 1000	D	DMT 1000/150
± 15, + 5	± 100, + 500	E	DLT 500/100
± 15, + 5	± 150, + 300	E	DLT 300/150
± 15, + 5	± 150, + 1000	D	DLT 1000/150

DIMENSIONS



Bottom View

Notes:
1. 4-40 Inserts .125 (3) Deep Min. (4 places).
2. Singles/Duals - 6 terminals.
   Triples - 7 terminals.

See columns a, d, and i for package outlines.

CONNECTIONS

Singles/Duals	Triples
Pin 1 + Vdc out	Pin 1 + 12/+ 15 Vdc out
2 Common out *	2 Common out
3 — Vdc out	3 - 12/ - 15 Vdc out
4 No connect	4 + 5 Vdc out
5 AC in	5 5 Vdc Rtn
6 AC in	6 AC in
7 (No terminal)	7 AC in

* Vdc Out on single output models.

OPTIONS:

M2 200 - 252 VAC Input
M3 105 - 125/210 - 250 VAC Input
M5 Terminals
M6 Faraday Shield
M7 Overvoltage Protection

	a	b	c	d	e	f	g	h	i	j
E in(mm)	4.00 (101.6)	2.5 (63.5)	1.25 (31.7)	2.7 (68.6)	.42 (10.6)	1.0 (25.4)	2.0 (50.8)	2.4 (61)	1.45 (36.8)	.83 (21.1)
D in(mm)	4.00 (101.6)	2.5 (63.5)	1.25 (31.7)	2.7 (68.6)	.42 (10.6)	1.0 (25.4)	2.0 (50.8)	2.4 (61)	2.0 (50.8)	1.38 (35)

GENERAL SPECIFICATIONS

Electrical

Input: 105 to 125Vac, 50 hz to 440 hz std.
Output Voltage Set Accuracy: ± .5%
Load Regulation: 0.1% of V out (no load to full load)
Line Regulation: 0.05% of V out (low line to high line)
Ripple: 1 mV P-P max
Transient Response: 1 mV P-P for less than 1 usec.
Temperature Coefficient: .02%/°C
Isolation Resistance Input to Output: Greater than 500 megohms.
Hi Pot Input To Output: 1750 Vrms (2500 Vdc)
Current Foldback/Short Circuit Prot.: (Standard all models).

Environmental

Operating: — 25°C to + 70°C ambient
Storage: — 40°C to + 85°C

Mechanical

Case: Bakelite/Diallylphthalate. Black
Encapsulation: Epoxy
Mounting. Two 4-40 Inserts (PC mount)
Four 4-40 Inserts (Chassis mount)

Connections

1. P.C. Pins, .250 Long Min
2. Terminal Blocks, only on chassis mount units

WARRANTY

Raytheon warrants all parts of equipment of its manufacture, except special purpose tubes and semiconductor devices which carry their own manufacturer's warranty, to be free from defects caused by faulty material or poor workmanship. Raytheon warrants its products to conform to applicable commercial or military specifications when confirmed on the Order Acknowledgement form to be free from defects caused by faulty material or poor workmanship. Raytheon's obligation is limited under the warranty to repair or replacement of products in kind, or at its sole option to issuance of a credit of original purchase price. Returns must be accompanied by a Raytheon Return Authorization form and conform to standard conditions of adjustment. The aforesaid warranty shall expire 36 months following the last day of the month of shipment from Raytheon's plant. The foregoing states the entire warranty extended by Raytheon. No other warranty, expressed or implied, is made, and specifically, Raytheon makes no warranty of merchantability or fitness for any purpose. In no case shall Raytheon be liable for any special or consequential damages. Authorization must be obtained prior to return of defective items.

SORENSEN
RAYTHEON

Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

- Built to your specific requirements from standard Sorensen Power Supplies with proven reliability and performance

If you need a low cost multi-output power supply without the expense of custom engineering or manufacturing, take a close look at Sorensen power assemblies.

98* different power supplies are available, offering a choice of linear and switching models with fixed or adjustable outputs.

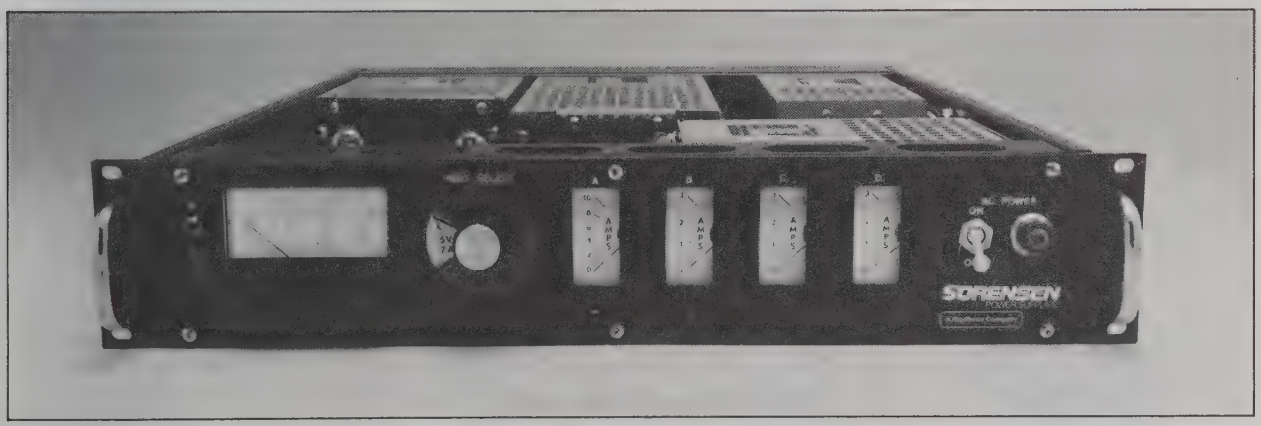
Every power assembly is shipped completely wired and tested ready for installation. AC input and output terminals are provided to match the power requirements at each output. Programming and sense terminals are also all pre-wired to terminal boards at the back of the rack.

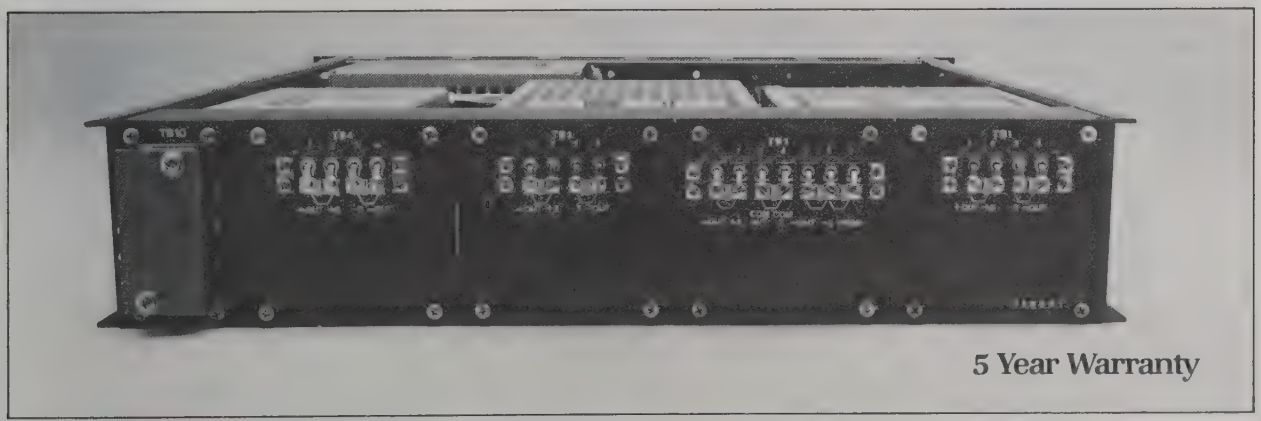
- Sorensen Power Assemblies; custom multiple output power supplies
- 5 year warranty

It's very simple to specify a Sorensen power assembly. Just call your local sales office or the main plant and tell them the parameters of each output you require. At no cost to you, we will configure an assembly to your requirements and give you a firm quotation and delivery date (delivery usually 4-6 weeks).

If your requirements cannot be met by a Sorensen standard power assembly, our design engineers will offer you an alternative special power assembly with advice on how we can build it at the lowest possible cost.

*See QRL and 488 DAP series for special power assembly stock rack configurations available for programmable power supplies.

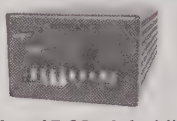




5 Year Warranty

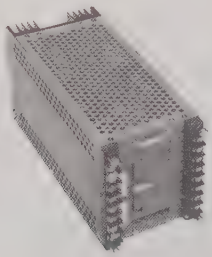
Power Assemblies

5 Power Supply Series
(See Pages 4.7-4.11)

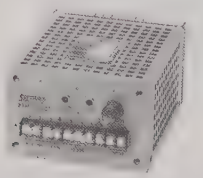


SSD Series-15 Models High Power Switching Power Supplies. 5V-48V dc. Models up to 528 watts output.

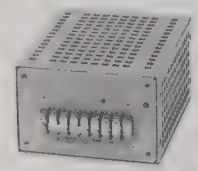
STM Series-18 Models High efficiency Switching Power Supplies. 5V-48V dc. Models up to 672 watts output.



SLC-B Series-27 Models Single output. 5V-28V dc. Models up to 300 watts.

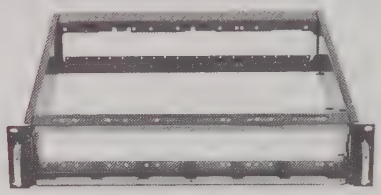


PTM Series-25 Models Single and Dual Output Linear Power Supplies. 5V-28V dc. Models up to 170 watts output.

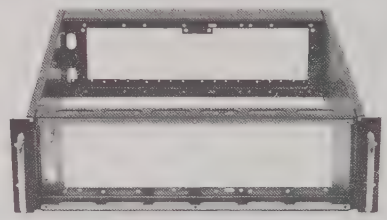


QSA Series-12 Models Wide Range Adjustable Linear Power Supplies. 0-10V dc to 200-300V dc. Models up to 58 watts output.

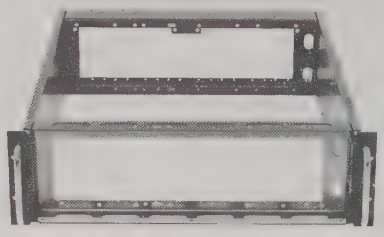
3 Standard Rack Sizes
3.5″ or 5.25″ panel heights



System 319 Up to 5 supplies. Up to 330V. Up to 45A. 3.5″ x 19″ x 19.4″ (See Page 4.7)



System 519 Up to 5 supplies. Up to 330V. Up to 120A. 5.25″ x 19″ x 19.4″ (See Pages 4.8 and 4.9)



System 522 Up to 5 supplies. Up to 330V. Up to 120A. 5.25″ x 19″ x 22.4″ (See Pages 4.10 and 4.11)

Typical terminal board configuration

Note: Terminal boards are not availble for outputs over 100A. These must be connected direct to supply bus-bars.

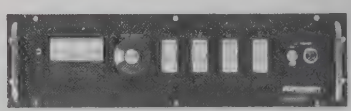
5 Panel Configurations

Panel A Blank panel.

Panel B Circuit breaker and pilot light.

Panel C Circuit breaker, pilot light and output voltage adjustment and light.

Panel D Metered panel with test points, voltage meter selection switch, current meters, breaker and light. Ammeters up to 100A.



Panel E Metered panel, test point, voltage meter, selection switch, current meters, output adjustments breaker and pilot light. Ammeters up to 100A.

SORENSEN
RAYTHEON
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

Single Output Power Supplies

Model	Current @40°C A dc	Input Voltage V ac	Input Voltage V dc	Regulation Line mV	Regulation Load mV	Ripple mVrms (typ)	Ripple mVpk-pk (typ)	Weight lb/kg	Case
5 Volt									
PTM 5-4	4	115/220/230	—	0.02% + 1	0.03% + 4	1	5	5.5/2.5	I
SLC 5-6B	6	115/230	—	0.2%	0.2%	—	50	1.5/0.7	IA
PTM 5-7	7	115/220/230	—	0.02% + 1	0.03% + 4	1	5	7.5/3.4	II
PTM 5-11	11	115/220/230	—	0.02% + 1	0.03% + 4	1	5	11.0/5.0	III
SLC 5-11B	11	115/230	—	0.2%	0.2%	—	50	3.0/1.4	IB
PTM 5-16	16	115/220/230	—	0.02% + 1	0.03% + 4	1	5	13.5/6.1	IIIB
SLC 5-20B	20	115/230	—	0.2%	0.2%	—	50	3.0/1.4	2A
STM 5-24	24	115	127-173	0.025% + 1	0.025% + 4	5	30	9.0/4.1	III
SLC 5-30B	30	115/230	—	0.2%	0.2%	—	50	4.2/1.9	2B
SSD 5-30	36	115/220	255/345	0.02% + 1	0.01% + 1	5	20	5.5/2.5	III
STM 5-36	36	115	127-173	0.025% + 1	0.025% + 1	5	30	9.0/4.1	IIIA
SLC 5-40B	40	115/230	—	0.2%	0.2%	—	50	4.2/1.9	3
SSD 5-45	45	115/220	255-345	0.01% + 1	0.01% + 1	5	20	5.5/2.5	IIIA
SLC 5-60B	40	115/230	—	0.1%	0.3%	—	50	7.9/3.6	4
STM 5-60	60	115	127-173	0.025% + 1	0.025% + 1	5	30	17.25/7.8	IVA
SSD 5-75	75	115/220	255-345	0.01% + 1	0.01% + 1	12	60	14/6.4	IVB
STM 5-100	100	115	127-173	0.025% + 1	0.025% + 1	5	30	23.75/10.7	VI
12 Volt									
SLC 12-2.5B	2.5	115/230	—	0.2%	0.2%	—	100	1.5/0.7	IA
PTM 12-2.7	2.7	115/220/230	—	0.02% + 1	0.03% + 4	1	5	5.5/2.5	I
PTM 12-4.4	4.4	115/220/230	—	0.02% + 1	0.03% + 4	1	5	7.5/3.4	II
SLC 12-4.5B	4.5	115/230	—	0.2%	0.2%	—	100	3.0/1.4	IB
PTM 12-6.5	6.5	115/220/230	—	0.02% + 1	0.03% + 4	1	5	11.0/5.0	III
SLC 12-8B	8	115/230	—	0.2%	0.2%	—	100	3.0/1.4	2A
PTM 12-10.5	10.5	115/220/230	—	0.02% + 1	0.03% + 4	1	5	13.5/6.1	IIIB
SLC 12-12B	12	115/230	—	0.2%	0.2%	—	100	4.2/1.9	2B
STM 12-12	12	115	127-173	0.025% + 1	0.025% + 1	5	30	6.5/2.9	III
SSD 12-15	15	115/220	255-345	0.01% + 1	0.01% + 1	5	20	5.5/2.5	III
SLC 12-16.7B	16.7	115/230	—	0.2%	0.2%	—	100	4.2/1.9	3
STM 12-20	20	115	127-173	0.025% + 1	0.025% + 1	5	30	9.0/4.1	IIIA
SSD 12-22	22	115/220	255-345	0.01% + 1	0.01% + 1	5	20	7.5/3.4	IIIA
SLC 12-25B	25	115/230	—	0.1%	0.3%	—	100	7.9/3.6	4
STM 12-30	30	115	127-173	0.025% + 1	0.025% + 1	5	30	17.25/7.8	IVA
STM 12-50	50	115	127-173	0.025% + 1	0.025% + 1	5	30	23.75/10.7	VI
15 Volt									
SLC 15-2B	2	115/230	—	0.2%	0.2%	—	100	1.5/0.7	IA
PTM 15-2.4	2.4	115/220/230	—	0.02% + 1	0.03% + 4	1	5	5.5/2.5	I
PTM 15-3.5	3.5	115/220/230	—	0.02% + 1	0.03% + 4	1	5	7.5/3.4	II
SLC 15-3.6B	3.6	115/230	—	0.2%	0.2%	—	100	3.0/1.4	IB
PTM 15-5.5	5.5	115/220/230	—	0.02% + 1	0.03% + 4	1	5	11.0/5.0	III
PTM 15-9.5	9.5	115/220/230	—	0.02% + 1	0.03% + 4	1	5	13.5/6.1	IIIB
SLC 15-10B	10	115/230	—	0.2%	0.2%	—	100	4.2/1.9	2B
SSD 15-12	12	115/220	255/345	0.01% + 1	0.01% + 1	5	20	5.5/2.5	III
SLC 15-13.3B	13.3	115/230	—	0.2%	0.2%	—	100	4.2/1.9	3
STM 15-24	24	115	127-173	0.025% + 1	0.025% + 1	5	30	17.25/7.8	IVA
STM 15-32	32	115	127-173	0.025% + 1	0.025% + 1	5	30	23.75/10.7	VI

Specifications subject to change without notice.

Single Output Series
Models SSD, STM, SLC-B and PTM Specifications

Single Output Power Supplies (Cont'd.)

Model	Current @40°C A dc	Input Voltage V ac	Input Voltage V dc	Regulation Line mV	Regulation Load mV	Ripple mVrms (typ)	Ripple mVpk-pk (typ)	Weight lb/kg	Case
20 Volt									
SLC 20-1.5B	1.5	115/230	—	0.2%	0.2%	—	100	1.5/0.7	IA
SLC 20-2.75B	2.75	115/230	—	0.2%	0.2%	—	100	3.0/1.4	IB
SLC 20-5B	5	115/230	—	0.2%	0.2%	—	100	3.0/1.4	2A
SLC 20-7.5B	7.5	115/230	—	0.2%	0.2%	—	100	4.2/1.9	2B
24 Volt									
SLC-24-1.2B	1.2	115/230	—	0.2%	0.2%	—	100	1.5/0.7	IA
PTM 24-1.6	1.6	115/220/230	—	0.02% + 1	0.03% + 4	1	5	5.5/2.5	I
SLC 24-2.2B	2.2	115/230	—	0.2%	0.2%	—	100	3.0/1.4	1B
PTM 24-2.3	2.3	115/220/230	—	0.02% + 1	0.03% + 4	1	5	7.5/3.4	II
SLC 24-4B	4	115/230	—	0.2%	0.2%	—	100	3.0/1.4	2A
PTM 24-4	4	115/220/230	—	0.02% + 1	0.03% + 4	1	5	11.0/5.0	III
SLC 24-6B	6	115/230	—	0.2%	0.2%	—	100	4.2/1.9	2B
PTM 24-6.8	6.8	115/220/230	—	0.02% + 1	0.03% + 4	1	5	13.5/6.1	IIIB
SLC 24-8.3B	8.3	115/230	—	0.2%	0.2%	—	100	4.2/1.9	3
STM 24-8.5	8.5	115	127/173	0.025% + 1	0.025% + 1	5	30	6.5/2.9	III
SSD 24-8.5	8.5	115/220	255/345	0.01% + 1	0.01% + 1	5	20	5.5/2.5	III
SLC 24-12.5B	12.5	115/230	—	0.1%	0.3%	—	100	7.9/3.6	4
SSD 24-13	13	115/220	255/345	0.01% + 1	0.01% + 1	5	20	7.5/3.4	IIIA
STM 24-21	21	115	127/173	0.025% + 1	0.025% + 1	5	30	17.25/7.8	IVA
SSD 24-22	22	115/220	255/345	0.01% + 1	0.01% + 1	12	60	14.0/6.4	IVB
STM 24-28	28	115	127/173	0.025% + 1	0.025% + 1	5	30	23.75/10.7	VI
28 Volt									
PTM 28-1.4	1.4	115/220/230	—	0.02% + 1	0.03% + 4	1	5	5.5/2.5	I
PTM 28-2	2	115/220/230	—	0.02% + 1	0.03% + 4	1	5	7.5/3.4	II
PTM 28-3.5	3.5	115/220/230	—	0.02% + 1	0.03% + 4	1	5	11.0/5.0	III
PTM 28-6	6	115/220/230	—	0.02% + 1	0.03% + 4	1	5	13.5/6.1	IIIB
STM 28-7	7	115	127/173	0.025% + 1	0.025% + 1	5	30	6.5/2.9	III
SSD 28-7	7	115/220	255/345	0.01% + 1	0.01% + 1	5	20	5.5/2.5	III
SLC 28-10B	10	115/230	—	0.1%	0.3%	—	100	7.9/3.6	4
STM 28-11	11	115	127/173	0.025% + 1	0.025% + 1	5	30	9.0/4.1	IIIA
SSD 28-11	11	115/220	255/345	0.01% + 1	0.01% + 1	5	20	7.5/3.4	IIIA
STM 28-24	24	115	127/173	0.025% + 1	0.025% + 1	5	30	23.75/10.7	VI
36 Volt									
SSD 36-5	5	115/220	255-345	0.01% + 1	0.01% + 1	5	20	5.5/2.5	III
SSD 36-8	8	115/220	255/345	0.01% + 1	0.01% + 1	5	20	7.5/3.4	IIIA
48 Volt									
SSD 48-4	4	115/220	255/345	0.01% + 1	0.01% + 1	5	20	5.5/2.5	III
STM 48-10	10	115	127/173	0.025% + 1	0.015% + 1	5	30	17.25/7.8	IVA
STM 48-14	14	115	127/173	0.025% + 1	0.025% + 1	5	30	23.75/10.7	VI

Specifications subject to change without notice.

Dual and Wide Range Adjustable Output
Models PTM and QSA Specifications

Dual Output Power Supplies

Model	Current @40°C A dc	Input Voltage V ac	Regulation Line mV	Regulation Load mV	Ripple mVrms (typ)	Ripple mVpk-pk (typ)	Weight lb/kg	Case
±12 Volt								
PTM 12/1D	1	115/220/330	0.01% + 1	0.01% + 1	1	5	5.5/2.5	I
PTM 12/3D	3	115/220/230	0.01% + 1	0.01% + 1	1	5	13.5/6.1	III
±15 Volt								
PTM 15/.8D	0.8	115/220/330	0.01% + 1	0.01% + 1	.1	5	5.5/2.5	I
PTM 15/1.5D	1.5	115/220/230	0.01% + 1	0.01% + 1	1	5	7.5/3.4	II
PTM 15/2.8D	2.8	115/220/230	0.01% + 1	0.01% + 1	1	5	13.5/6.1	III

Wide Range Adjustable Output Power Supplies

Model	Current @40°C A dc	Input Voltage V ac	Regulation Line mV	Regulation Load mV	Ripple mVrms (typ)	Ripple mVpk-pk (typ)	Weight lb/kg	Case
0-10 Volt								
QSA 10-1.4	1.5	115/220/230	.004% + 0.2	.008% + 0.2	0.3 (max)	3 (max)	5.5/2.5	I
QSA 10-3.7	4.0	115/220/230	.004% + 0.2	.008% + 0.2	0.3 (max)	3 (max)	13.5/6.1	III
14-22 Volt								
QSA 18-1.1	1.2	115/220/230	.008%	.012%	0.3 (max)	3 (max)	5.5/2.5	I
QSA 18-1.9	2.1	115/220/230	.008%	.012%	0.3 (max)	3 (max)	7.5/3.4	II
QSA 18-3.0	3.3	115/220/230	.008%	.012%	0.3 (max)	3 (max)	13.5/6.1	III
35-60 Volt								
QSA 48-0.4	0.44	115/220/230	.008%	.012%	0.3 (max)	3 (max)	5.5/2.5	I
QSA 48-0.8	0.88	115/220/230	.008%	.012%	0.3 (max)	3 (max)	7.5/3.4	II
QSA 48-1.2	1.3	115/220/230	.008%	.012%	0.3 (max)	3 (max)	13.5/6.1	III
60-90 Volt								
QSA 75-0.5	0.55	115/220/230	.008%	.012%	0.3 (max)	3 (max)	7.5/3.4	II
90-150 Volt								
QSA 120-0.5	0.55	115/220/230	.008%	.012%	0.3 (max)	3 (max)	13.5/6.1	III
150-200 Volt								
QSA 175-0.25	0.28	115/220/230	.008%	.012%	0.3 (max)	3 (max)	13.5/6.1	III
200-330 Volt								
QSA 265-0.15	0.17	115/220/230	.008%	.012%	0.3 (max)	3 (max)	13.5/6.1	III

Specifications subject to change without notice.

Standard Rack Size

Choose from 3 Standard Rack Sizes

See back of catalog for Request for Quotation forms.

Chassis 319 For power supplies with case size I, IA, II, III, IB, 2A, IIIA power supplies with output up to 45A or 336 watts.

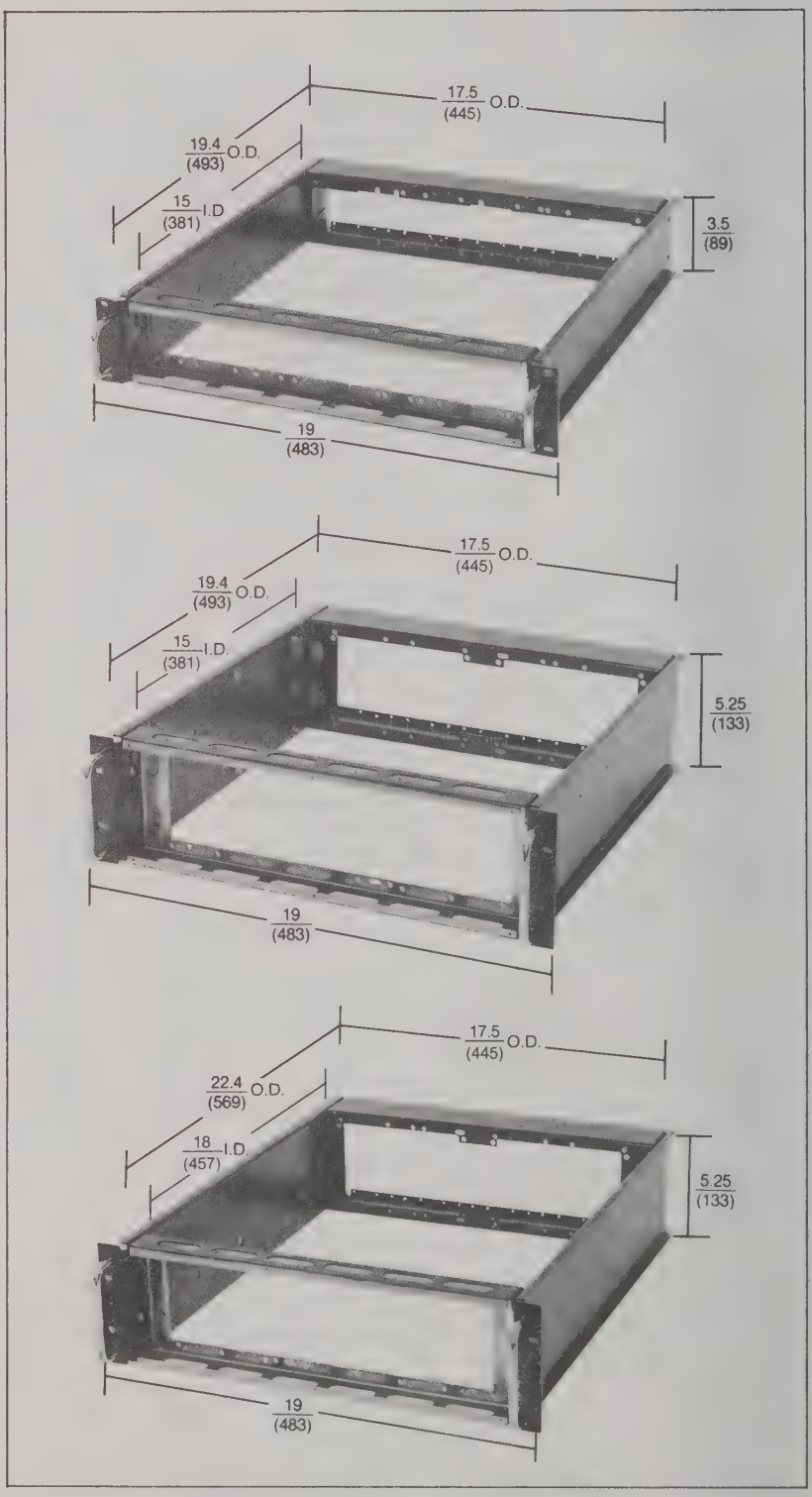
Panel size: 3.5 x 19.0 in. (89 x 483 mm)

Chassis 519 For power supplies with case size I, IA, II, III, IB, IIIB, 2A, 2B, IIIA, 3, 4, IVA, IVB or VI, i.e. power supplies with output up to 120A or 768 watts.

Panel size: 5.25 x 19.0 in. (133 x 483 mm)

Chassis 522 For all models in SSD, SLC-B, STM, PTM and QSA series, i.e. single output up to 120A or 768 watts.

Panel size: 5.25 x 19.0 in. (133 x 483 mm)



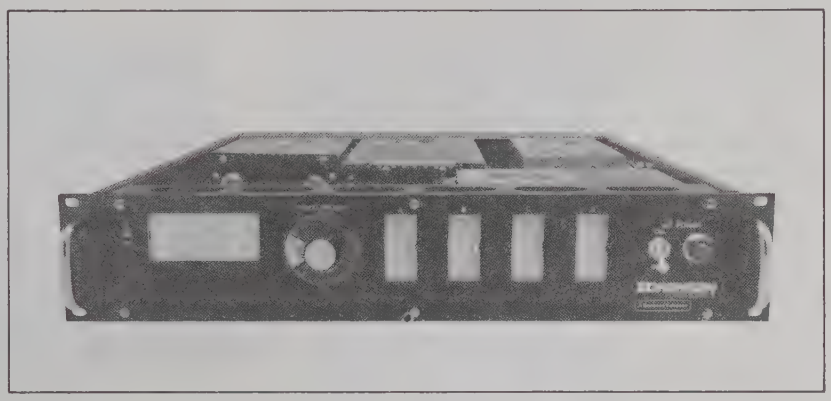
Note: All dimensions are in inches (mm)

See pages 4.12 thru 4.14 for rack accessories and sub-assemblies.

SORENSEN RAYTHEON Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

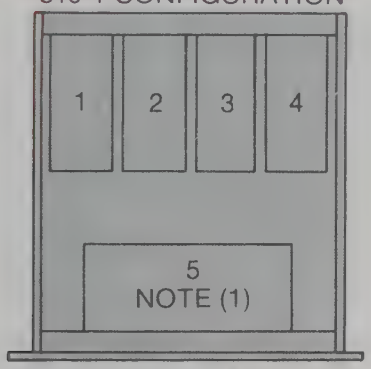
System Example: System 319-E3 comes completely assembled, wired, burned-in, tested and ready for use in your application. (In the suffix -E3, the letter defines front panel style and the number indicates module configuration.)
2 x STM 12-12 (12V @ 12A)
2 x PTM 5-4 (5V @ 4A)
Typical configuration system 319-E3.

3.5 x 19 x 19.4 in.
(89 x 483 x 493 mm)



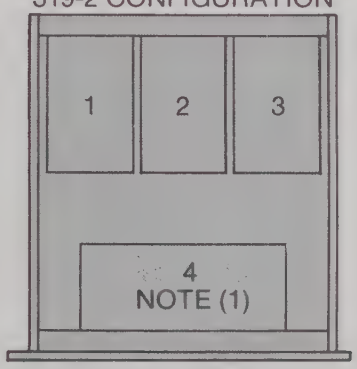
Typical Power Supply Case Configurations

319-1 CONFIGURATION



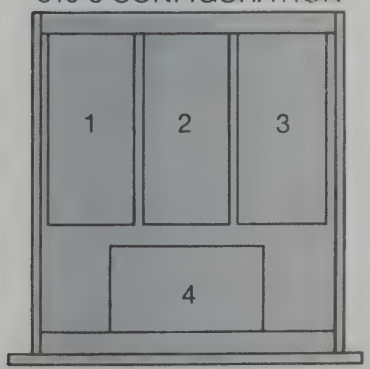
Up to 5 Case I Modules

319-2 CONFIGURATION



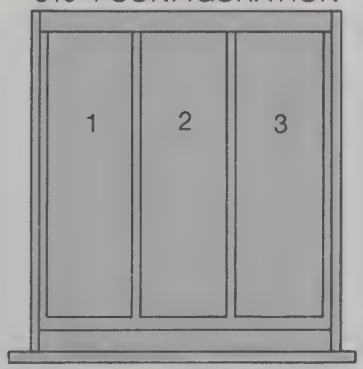
Up to 4 Case II Modules

319-3 CONFIGURATION



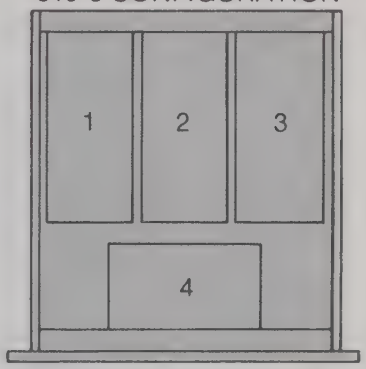
Up to 4 Case III Modules

319-4 CONFIGURATION



Up to 3 Case IIIA Modules

319-5 CONFIGURATION



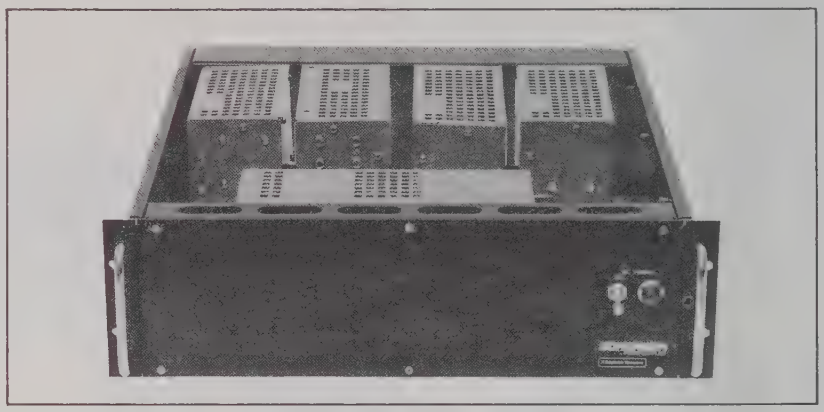
Up to 4 Case IA, IB, 2A SLC-B Modules

NOTES: (1) Case IIIA, III, II or I allowable in this position.

System 519
Power Assembly

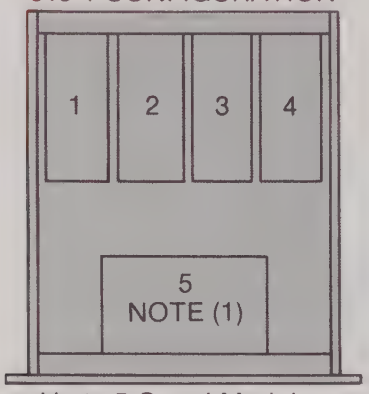
System Example: System 519-B2 comes completely assembled, wired, burned-in, tested and ready for use in your application. (In the suffix -B2, the letter defines front panel style and the number indicates module configuration.)
1 x PTM 5-7 (5V @ 7A)
1 x PTM 15-3.5 (15V @ 3.5A)
1 x PTM 12-4.4 (12V @ 4.4B)
1 x SSD 5-45 (5V @ 45A)
Typical configuration system 519-B2.

5.25 x 19 x 19.4 in.
(133 x 483 x 493 mm)



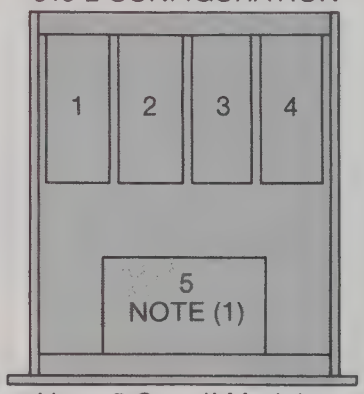
Typical Power Supply Case Configurations

519-1 CONFIGURATION



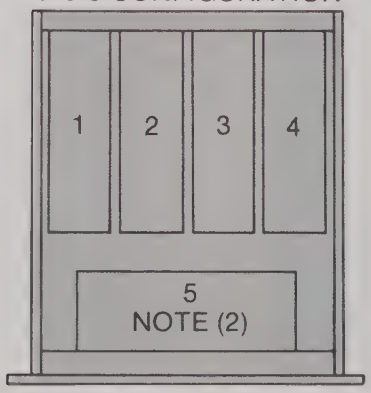
Up to 5 Case I Modules

519-2 CONFIGURATION



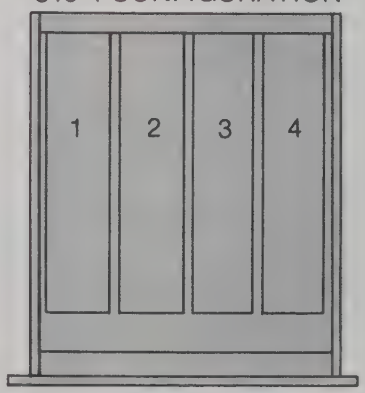
Up to 5 Case II Modules

519-3 CONFIGURATION



Up to 5 Case III Modules

519-4 CONFIGURATION



Up to 4 Case IIIA Modules

NOTE: (1) Case IIIB, IIIA, III, II, or I allowable in this position.
(2) Case IIIA, III, II, or I allowable in this position provided no QSA with OVP is mounted in position 1-4.

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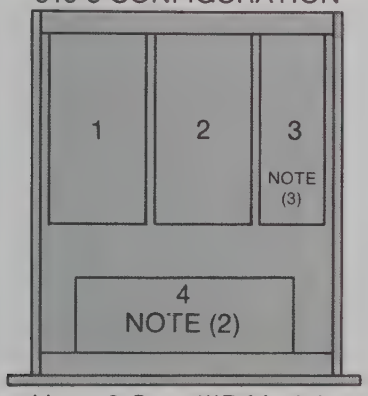
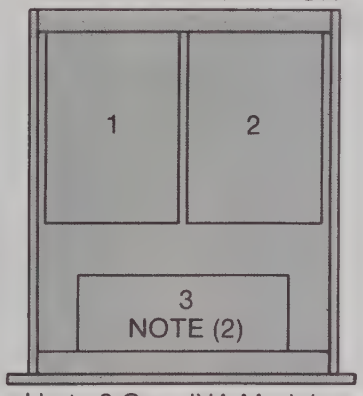
519-5 CONFIGURATION



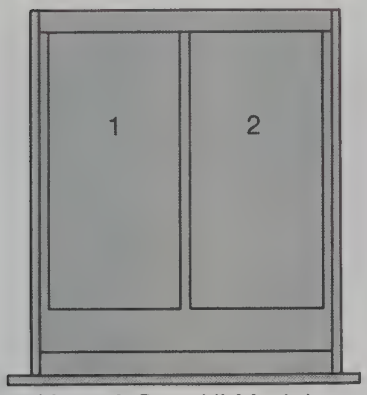
Up to 2 Case IIIB Modules

519-6 CONFIGURATION



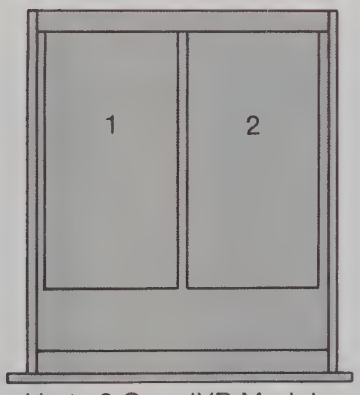
Up to 2 Case IVA Modules

519-7 CONFIGURATION



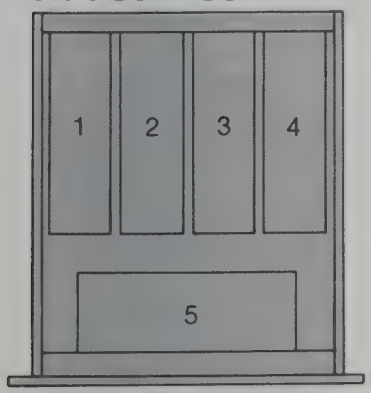
Up to 2 Case VI Modules

519-8 CONFIGURATION



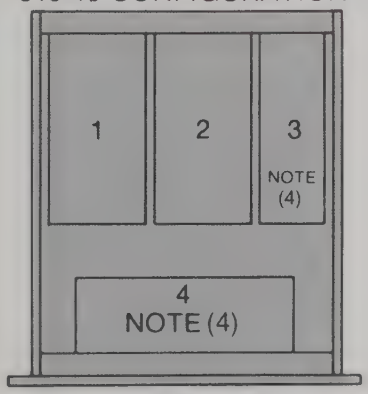
Up to 2 Case IVB Modules

519-9 CONFIGURATION



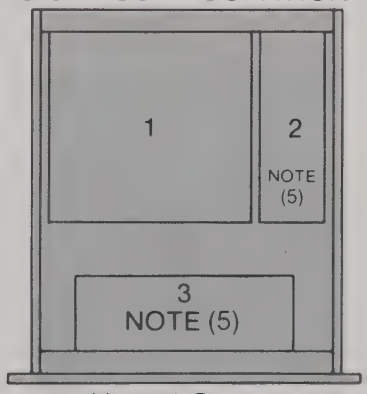
Up to 5 Case IA, IB, 2A
SLC-B Modules

519-10 CONFIGURATION



Up to 2 Case 2B, 3
SLC-B Modules

519-11 CONFIGURATION



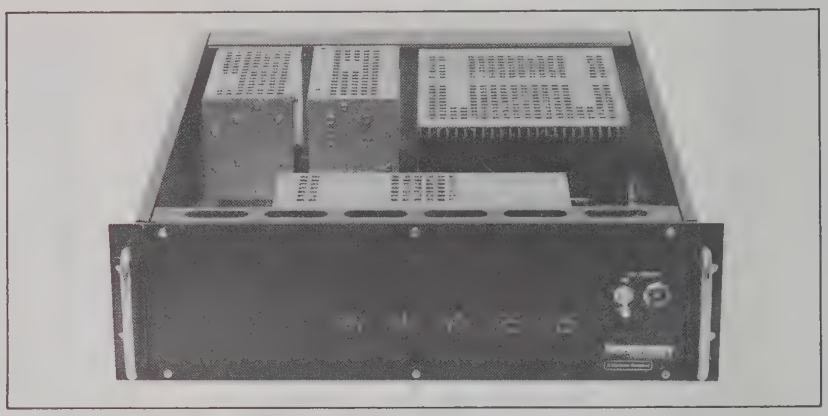
Up to 1 Case 4
SLC-B Modules

NOTES: (2) Case IIIA, III, II or I allowable in this position provided no QSA with OVP is mounted in positions 1-3 (519-5) or 1-2 (519-6).
(3) Module III, II or I allowable in this position.
(4) Case IA, IB, 2A allowable in this position.
(5) Case IA, IB, 2A, 2B allowable in this position.

System 522
Power Assembly

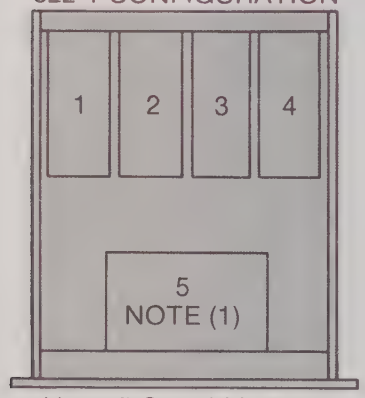
System Example: System 522-C6 comes completely assembled, wired, burned-in, tested and ready for use in your application. (In the suffix -C6, the letter defines front panel style and the number indicates module configuration.)
1 x STM 5-60 (5V @ 60A)
1 x PTM 12-6.5 (12V @ 6.5A)
1 x STM 28-7 (28V @ 7A)
1 x SSD 24-13 (24V @ 13A)
Typical configuration system 522-C6.

5.25 x 19 x 22.4 in.
(133 x 483 x 569 mm)



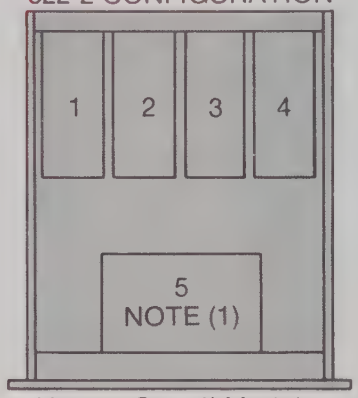
Typical Power Supply Case Configurations

522-1 CONFIGURATION



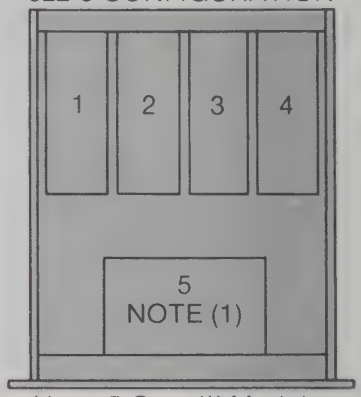
Up to 5 Case I Modules

522-2 CONFIGURATION



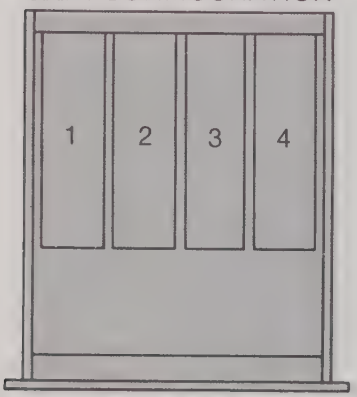
Up to 5 Case II Modules

522-3 CONFIGURATION



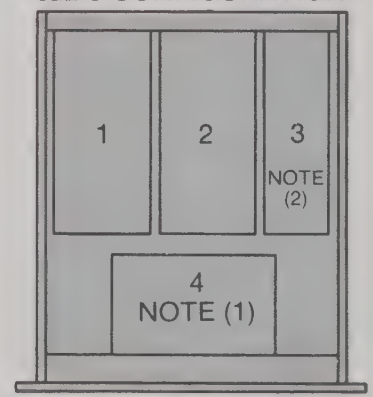
Up to 5 Case III Modules

522-4 CONFIGURATION



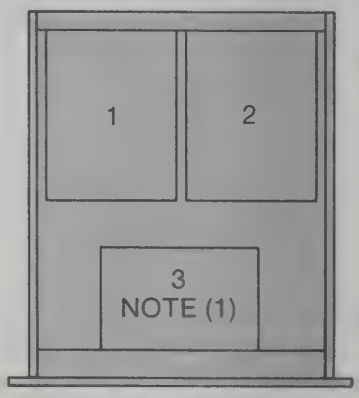
Up to 4 Case IIIA Modules

522-5 CONFIGURATION



Up to 3 Case IIIB Modules

522-6 CONFIGURATION



Up to 2 Case IVA Modules

NOTES: (1) Case IIIB, IIIA, III, II or I allowable in this position.
(2) Case III, II, or I allowable in this position.

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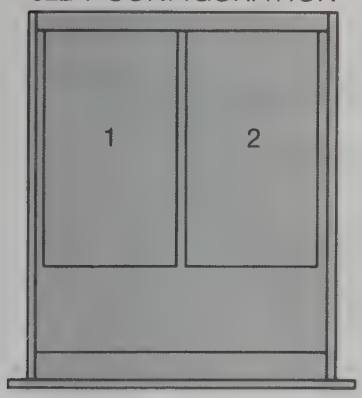
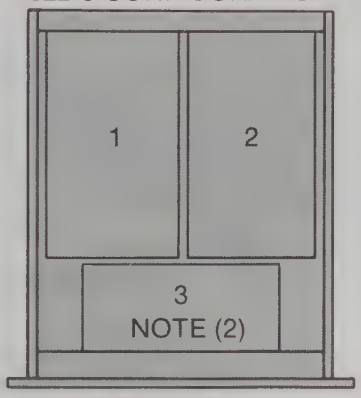
522-7 CONFIGURATION



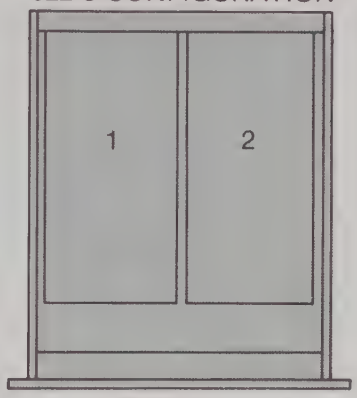
Up to 2 Case VI Modules

522-8 CONFIGURATION



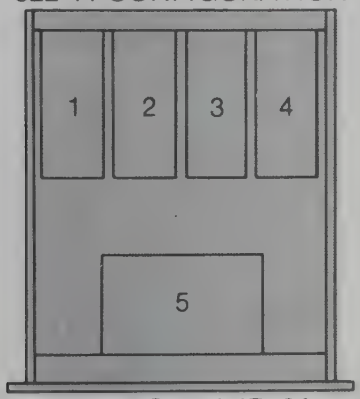
Up to 2 Case IVB Modules

522-9 CONFIGURATION



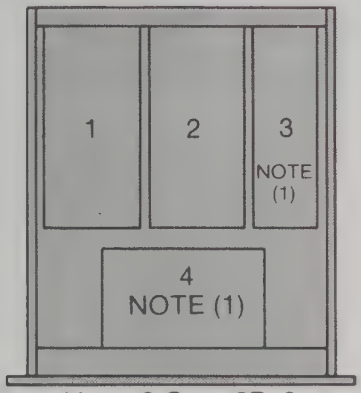
Up to 2 Case VIA Modules

522-11 CONFIGURATION



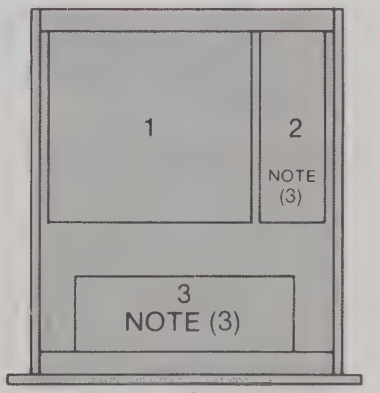
Up to 5 Case I; IB, 2A
SLC-B Modules

522-12 CONFIGURATION



Up to 2 Case 2B, 3
SLC-B Modules

522-13 CONFIGURATION



Up to 1 Case 4
SLC-B Modules

NOTES: (1) Case IA, IB, 2A allowable in this position.
(2) Case III, II, or I allowable in this position.
(3) Case 1A, 1B, 2A, 2B allowable in this position.

Power Assemblies

Rack Accessories (standard)

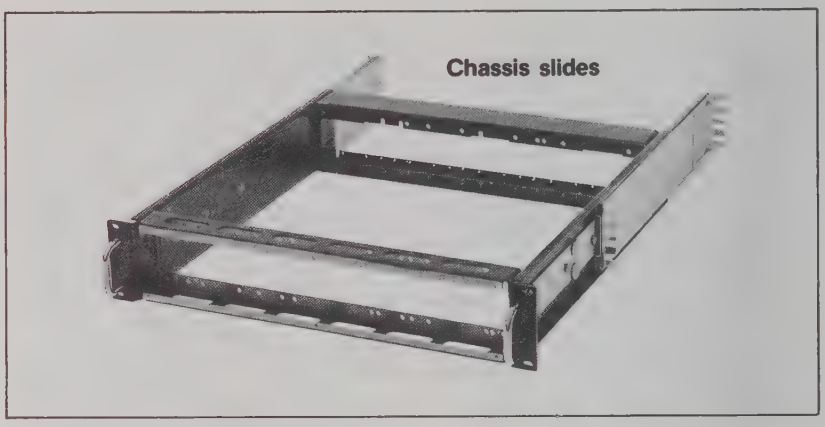
Chassis slides Available for chassis 319, 519 and 522.

AC 319 Kit #587552-1
AC 519 Kit #587552-1
AC 522 Kit #587552-2

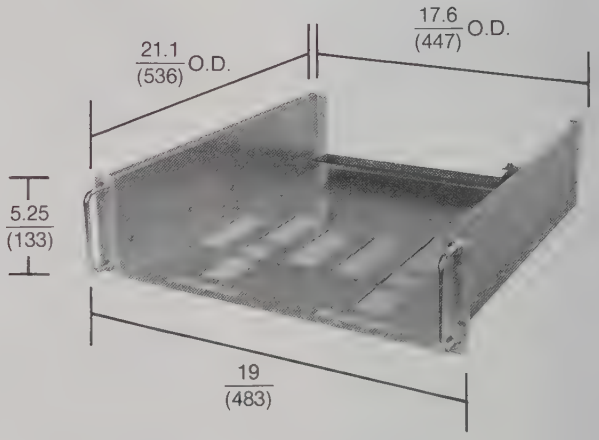
Line Cord Standard line cord terminated to ac input (18A max limit)

Open-Sense Diode Protection Eliminates power supply responding to accidental remote sense open circuit

To specify your rack assembly power supply requirements, copy the form on page 7.3



RA500 Series
Power Assemblies



Note: All dimensions are in inches (mm)

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Rack Sub-Assemblies (standard)

Because of the complexity of Power Assemblies, it is recommended that you purchase a factory-assembled system as described previously. However, in certain special applications, you may prefer to design and assemble your own system. For these applications, Sorensen offers selected sub-assemblies and accessories.

Select the desired sub-assembly from the listing below. This will be determined by the size and number of the models to be assembled.

Note that you must provide any front panel controls or metering using the blank panel offered. No rear panels are available.

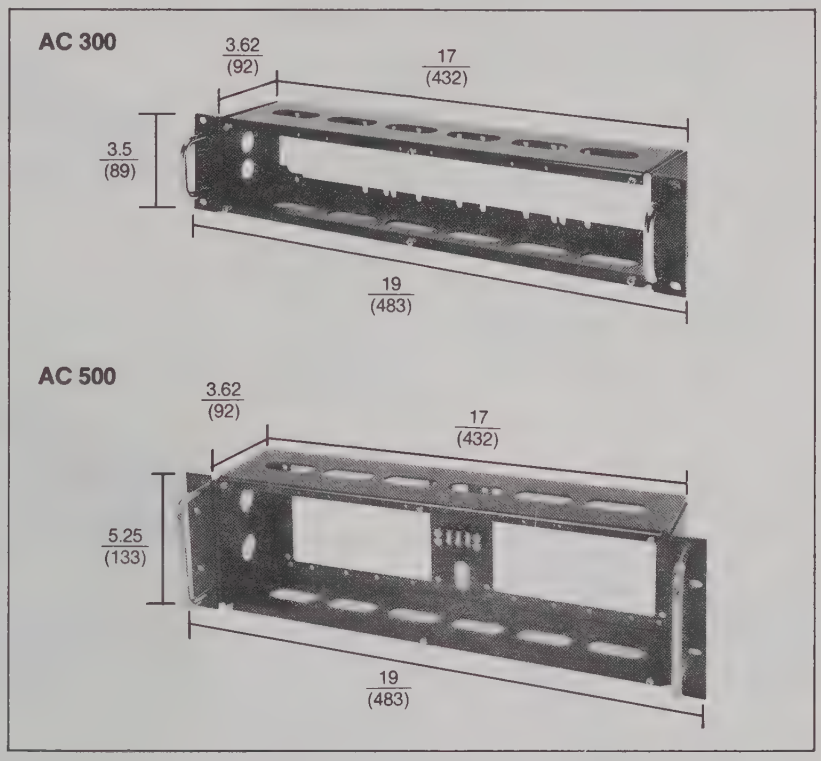
For these units you must assemble and wire the modules, and test the completed system.

AC300 Rack Chassis
Accepts up to 4 Case I Power Supplies
Accepts up to 3 Case II Power Supplies
Accepts up to 3 Case III Power Supplies

Accepts PF 300 blank panel

AC500 Rack Chassis
Accepts up to 4 Case I Power Supplies
Accepts up to 4 Case II Power Supplies
Accepts up to 4 Case III Power Supplies
Accepts up to 4 Case IIIA Power Supplies
Accepts up to 2 Case IIIB, IV, IVA, VI Power Supplies

Accepts PF500 blank panel



Note: All dimensions are in inches (mm)

Rack Sub-Assemblies

AC-318 Rack Chassis

Accepts up to 8 Case I Power Supplies
Accepts up to 6 Case II Power Supplies
Accepts up to 4 Case III Power Supplies

Accepts PF 300 blank panel
Accepts Slide Kit #587552-1

AC-319 Rack Chassis

See page 4.6 for case size and dimensions.

Accepts PF 300 blank panel
Accepts Slide Kit #587552-1

AC-320 Rack Chassis

Accepts up to 8 Case I Power Supplies
Accepts up to 6 Case II Power Supplies
Accepts up to 4 Case III Power Supplies

Accepts PF 300 blank panel
Accepts Slide Kit #587552-2

AC-518 Rack Chassis

Accepts up to 8 Case I Power Supplies
Accepts up to 5 Case II or III Power Supplies
Accepts up to 4 Case IIIA Power Supplies
Accepts up to 3 Case IIIB Power Supplies
Accepts up to 2 Case IV, IVA or VI Power Supplies

Accepts PF 500 blank panel
Accepts Slide Kit #587552-1

AC-519 Rack Chassis

See page 4.6 for case size and dimensions.

Accepts PF 500 blank panel
Accepts Slide Kit #587552-1

AC-520 Rack Chassis

Accepts up to 8 Case I or II Power Supplies
Accepts up to 5 Case III or IIIA Power Supplies
Accepts up to 3 Case IIIB Power Supplies
Accepts up to 2 Case IV, IVA or VI Power Supplies

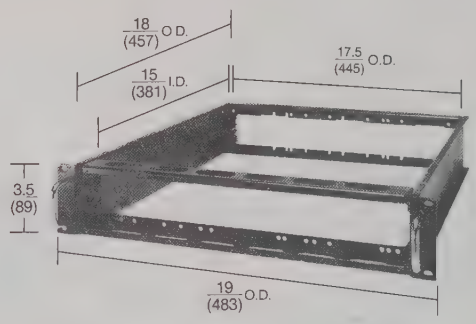
Accepts PF 500 blank panel
Accepts Slide Kit #587552-2

AC-522 Rack Chassis

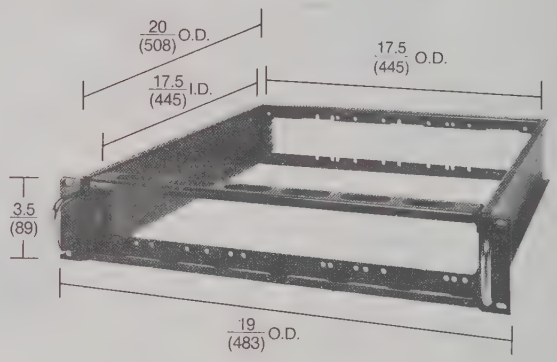
See page 4.6 for case size and dimensions.

Accepts PF 500 blank panel
Accepts Slide Kit #587552-2

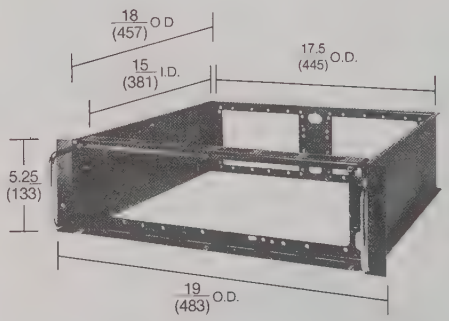
AC 318



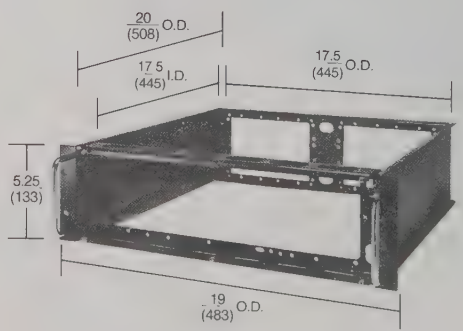
AC 320



AC 518



AC 520



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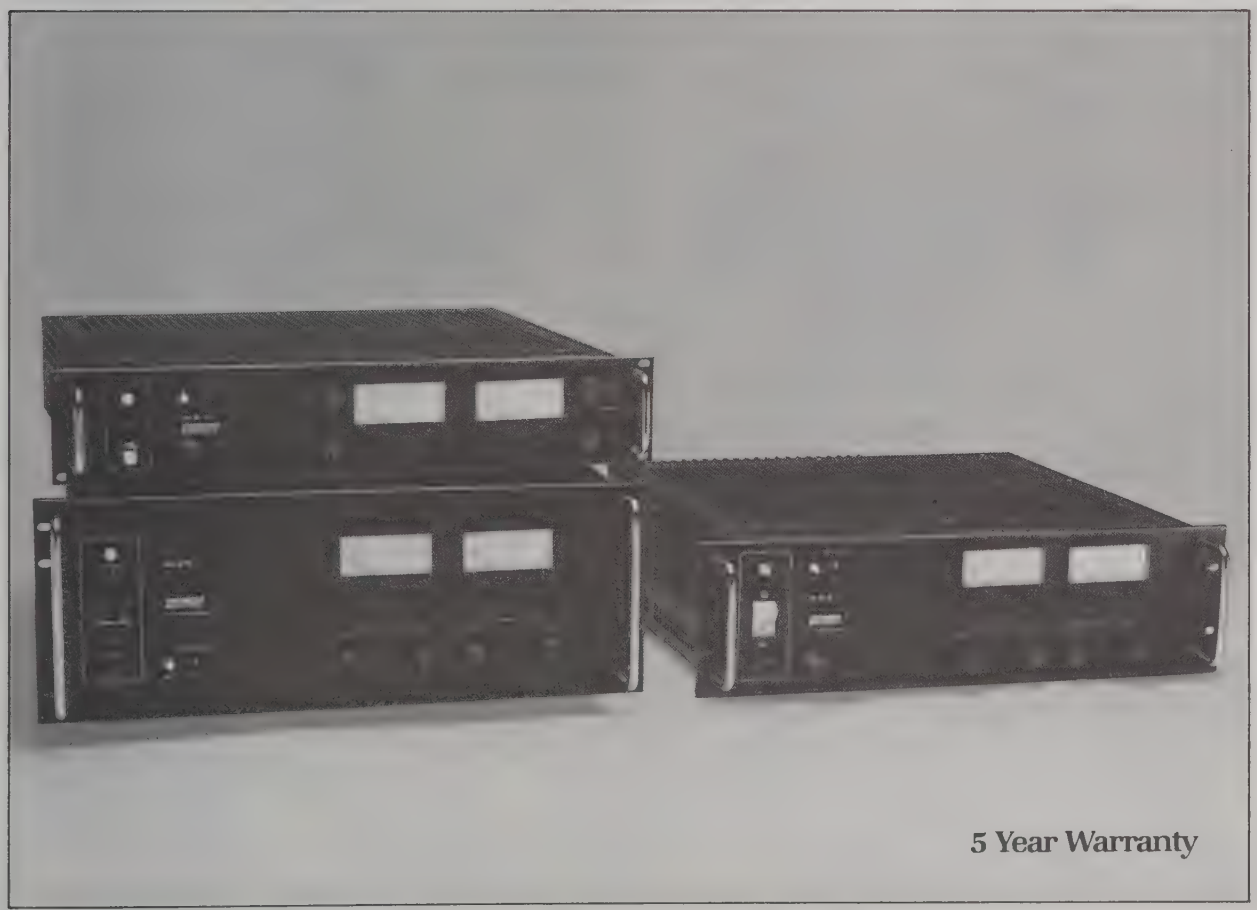
SORENSEN

Variable Programming Laboratory and Industrial Power Supplies SRL Series

- 14 models in voltage ranges from 0-10V dc to 0-60V dc with power levels from 250 to 2100 watts
- 115/208/230V ac single phase input available on all models except SRL 40-50 and SRL 60-35 which are 208/230V ac single phase only
- 50/60 Hz operation without derating
- SCR pre-regulation and linear series pass design provide high efficiency and performance with low rms ripple and pk-pk noise
- Remote voltage or resistance programming in voltage or current modes
- Excellent voltage or current regulation with automatic crossover
- Unique quick set and check of built-in overvoltage protection can be monitored and adjusted on front panel. Set point can be adjusted without removing load or ac power
- No overshoot at turn-on, turn-off or power failure
- 5 year warranty

The SRL series power supply incorporates all the benefits of a linear series pass design with pre-regulation to provide an additional bonus of high efficiency and outstanding performance.



5 Year Warranty

SRL Series
Model Specifications

DC OUTPUT
CONSTANT VOLTAGE MODE

Voltage Regulation:
Line and load combined:
.01% or 2mV, whichever is greater

Temperature Coefficient:
0.01% +0.2mV/°C.

Resistance Programming:
200 ohms per volt standard; (adjustable to 1000 ohms per volt through the use of externally added components).

Voltage Programming:
Volt per volt standard.

Stability:
0.025% +0.5mV for 8 hours after 30 minute warm-up time with constant line, load and operating temperature.

Remote Sensing:
1V maximum drop per load lead (rear terminal connection).

Transient Response:
150 μs (typical) to return to a bandwidth of ±10 mV for step load change of 0 to 100% of full load.

CONSTANT CURRENT MODE

Current Programming:
1000 ohms programs full rated output.

Voltage Signal Programming:
Consult factory or operating manual.

Current Regulation:
0.02% +6mA line or load.

Minimum Current:
Adjustable down to zero.

Temperature Coefficient:
0.01% +2mA per °C.

Stability:
0.03% +10mA (Typical for 8 hours after 30 minute warm-up time with constant line, load, and ambient operating temperature.)

AC INPUT

Voltage:
105-125V ac single phase (SRL 40-50 and SRL 60-35, 190-230V ac single phase).

Voltage Options:
190-230V ac add M1 to model number. 210-250V ac add M2 to model number. For M1 and M2 voltage options, consult factory for price.

Frequency:
47-63 Hz without derating.

OPERATING DATA

Ambient Operating Temperature Range:
0 to + 70°C

Storage Temperature Range:
−40°C to +85°C

Series Operation:
200V dc maximum.

Parallel Operation:
Master-slave or straight parallel; 3 units maximum in master slave.

RFI:
MIL 1-6181D

Automatic Crossover:
Automatic between voltage and current modes.

Overvoltage Protection:
Built-in adjustable crowbar, 10μs operation. May be checked or adjusted from front panel without removing ac power or load.

SRL ACCESSORIES

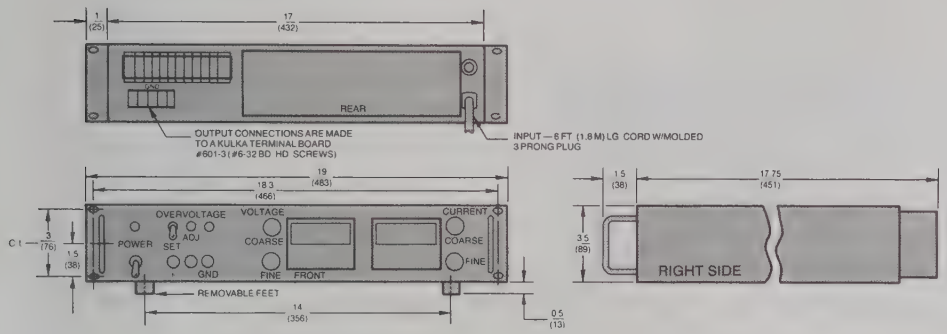
Chassis Slides (Kit):
Available for convection cooled models. See dimensional drawings.

Digital Programmer:
Available for all models in SRL series. IEEE-488 interface to GPIB bus. Order Model 488 DAP.

Model	Current (A dc) 40°C	55°C	70°C	Ripple Voltage Mode rms-	pk-pk	Current Mode rms	Case	Efficiency (typ)	Input Current Max. (A ac)*
0-10V									
SRL 10-25	27.5	25	16.7	350μV	20mV	10mA	II	46%	7.5
SRL 10-50	50.0	50	33.5	300μV	10mV	20mA	II	43%	14.7
SRL 10-100	100.0	100	67.0	300μV	20mV	30mA	III	46%	32.5
0-20V									
SRL 20-12	13.5	12	8.0	200μV	20mV	3mA	I	42%	7.8
SRL 20-25	27.5	25	16.7	300μV	20mV	10mA	II	53%	13.6
SRL 20-50	50.0	50	33.5	500μV	40mV	10mA	III	54%	28.0
0-40V									
SRL 40-6	7.5	6	4.0	200μV	20mV	0.5mA	I	56%	6.3
SRL 40-12	13.5	12	8.0	300μV	20mV	1mA	II	60%	13.2
SRL 40-25	25.0	25	16.7	500μV	10mV	10mA	II	60%	22.0
SRL 40-50	50.0	50	33.5	700μV	50mV	10mA	III	63%	25.0**
0-60V									
SRL 60-4	4.5	4	2.68	300μV	20mV	0.5mA	I	50%	6.0
SRL 60-8	9.0	8	5.36	300μV	20mV	1mA	II	64%	12.5
SRL 60-17	17.0	17	11.4	500μV	10mV	3mA	II	62%	22.0
SRL 60-35	35.0	35	23.4	700μV	40mV	10mA	III	67%	26.0**

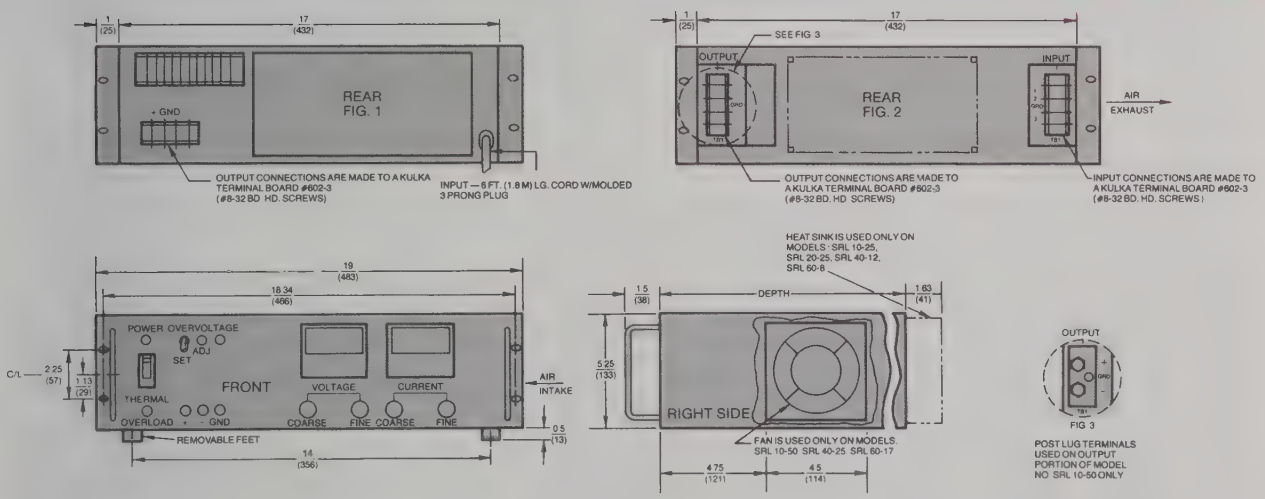
Specifications subject to change without notice.
*Standard model has 105-125V ac input. **Models SRL 40-50 and SRL 60-35 have 190-230V ac input.

CASE I (3.5" High)



Model	Net Weight lbs.	Net Weight kg.	Cooling	Slide Kit Part Number
SRL 20-12	45	20.4	Convection	587552-1
SRL 40-6	44	20.0	Convection	587552-1
SRL 60-4	44	20.0	Convection	587552-1

CASE II (5.25" High)

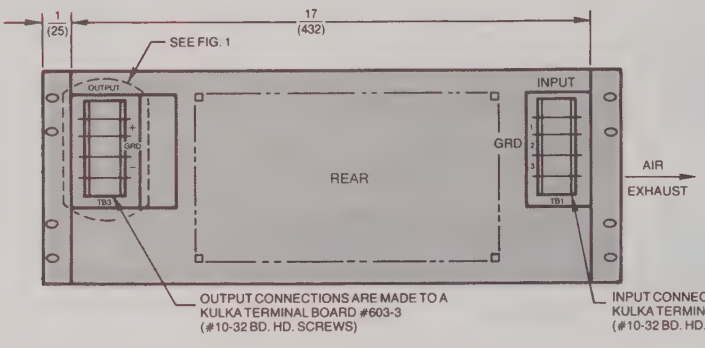

REAR
FIG. 1
+ GND
OUTPUT CONNECTIONS ARE MADE TO A KULKA TERMINAL BOARD #602-3 (#8-32 BD HD SCREWS)
INPUT — 6 FT. (1.8 M) LG. CORD W/MOLDED 3 PRONG PLUG
SEE FIG 3
OUTPUT
INPUT
REAR
FIG. 2
AIR EXHAUST
OUTPUT CONNECTIONS ARE MADE TO A KULKA TERMINAL BOARD #602-3 (#8-32 BD. HD SCREWS)
INPUT CONNECTIONS ARE MADE TO A KULKA TERMINAL BOARD #602-3 (#8-32 BD. HD. SCREWS)
POWER
OVERVOLTAGE
SET
FRONT
VOLTAGE
CURRENT
THERMAL
OVERLOAD
COARSE
FINE
AIR INTAKE
REMOVABLE FEET
HEAT SINK IS USED ONLY ON MODELS: SRL 10-25, SRL 20-25, SRL 40-12, SRL 60-8
DEPTH
RIGHT SIDE
FAN IS USED ONLY ON MODELS: SRL 10-50 SRL 40-25 SRL 60-17
OUTPUT
FIG 3
POST LUG TERMINALS USED ON OUTPUT PORTION OF MODEL NO SRL 10-50 ONLY

Model	Depth	Rear View	Net Weight lbs.	Net Weight kg.	Cooling	Slide Kit Part Number
SRL 10-25	16.2 (409)	Fig. 1	64	29	Convection	587552-1
SRL 10-50	21 (533)	Fig. 2	81	36	Fan	N/A
SRL 20-25	16.2 (409)	Fig. 1	64	29	Convection	587552-1
SRL 40-12	16.2 (409)	Fig. 1	64	29	Convection	587552-1
SRL 40-25	21 (533)	Fig. 2	95	43	Fan	N/A
SRL 60-8	16.2 (409)	Fig. 1	64	29	Convection	587552-1
SRL 60-17	21 (533)	Fig. 2	95	43	Fan	N/A

Note: All dimensions are in inches
(mm)

SRL Series
Dimensional Drawings

CASE III (7" High)



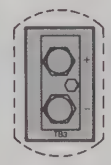
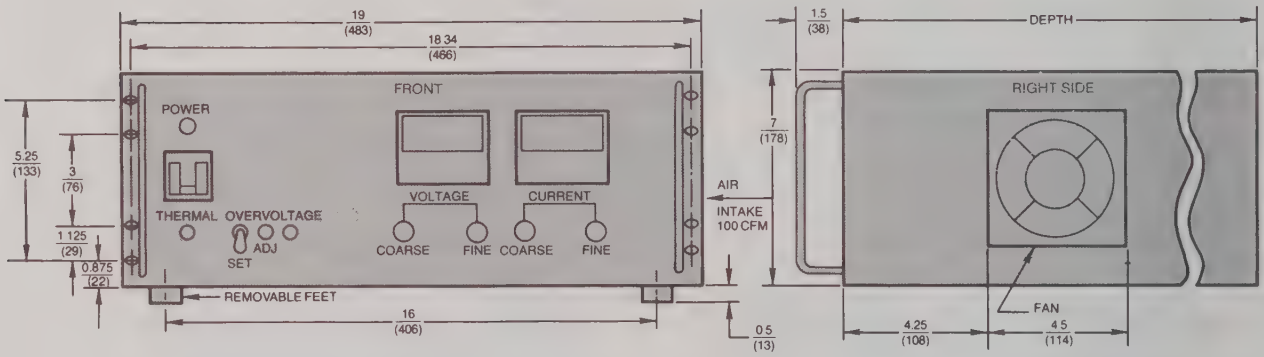


FIG. 1
POST LUG TERMINALS USED ON OUTPUT PORTION OF MODEL NO SRL 10-100 ONLY



Model	Depth	Weight lbs.	Weight kg.	Cooling
SRL 10-100	23 (584)	132	(60)	Fan
SRL 20-50	21 (533)	128	(58)	Fan
SRL 40-50	21 (533)	120	(54)	Fan
SRL 60-35	21 (533)	120	(54)	Fan

Note: All dimensions are in inches (mm)

SORENSEN
RAYTHEON

Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

SORENSEN

High Power Single Phase Input Laboratory and Industrial Power Supplies DCRB Series

- 31 models in nine voltage ranges from 0-7V dc to 0-600V dc with power levels from 400 to 2700 watts
- 115V ac single phase input standard (208/220/230V ac single phase optional) on all convection cooled models (up to 1800 watts)
- 208V ac single phase input standard (220/230V ac optional) on all fan cooled models (over 2000 watts)
- 50/60 Hz operation without derating
- Low ripple and noise
- Excellent voltage or current regulation with automatic crossover. Panel lights indicate operating mode.
- Remote voltage or resistance programming in voltage and current modes
- Adjustable Current Limiting (overload/short circuit protection) with automatic recovery
- Overvoltage protection standard on all models
- 5 year warranty

The DCRB series incorporates a single phase input SCR controlled regulator providing high efficiency and fully adjustable output power.

5 Year Warranty

DCRB Series
Specifications

DC OUTPUT
CONSTANT VOLTAGE MODE

Voltage Regulation:
Line and load combined
0-7 and 0-10V dc models
0.1% or 5mV, whichever is greater
0-20 to 0-80V dc models
0.05% or 10mV, whichever is greater
0-150 to 0-600V dc models
0.05% or 75mV, whichever is greater

Temperature Coefficient:
0.015%/°C of E_0 max.

Resistance Programming:
See model specification chart.

Voltage Programming:
Consult instruction manual.

Stability:
0.1% E_0 max for 8 hours after 30 minute warm-up.

Remote Sensing:
Maximum drop per load lead should not exceed 5% of E_0 max. or 3V, whichever is smaller.

Transient Response:
0-10 to 0-600V dc models
50mS (typical) to return to ±1%* band for step load change of 50 to 100% of full load.
* ±2% or 20V model, ±3% of 10V model.
0-7V dc model
100mS (typical) to return to ±3% band for step load change of 67 to 100% of full load.

CONSTANT CURRENT MODE

Current Regulation:
0.25% of I_0 max. line and load combined. (0.5% for 7V model)

Temperature Coefficient:
0.03%/°C. of I_0max.

Current Programming:
See model specification chart.

Stability:
0.15% of I_0 max. for 8 hours after 30 minute warm-up.

AC INPUT

Voltage:
103-127V ac single phase for models 400 to 1800 watts. 187-229V ac single phase for 2100-2700 watt models.

Voltage Options:
Optional inputs available. Consult local sales office or factory for modification price.

Frequency:
49-63 Hz single phase.
(Ripple and transient response specs apply only at 60 Hz).

OPERATING DATA

Ambient Operating Temperature Range:
0 to + 70°C

Storage Temperature Range:
-40°C to +85°C.

Efficiency:
61-86% depending on model.

Series Operation:
200V dc max. output (150 and 300V models two in series).

Parallel Operation:
Master-slave or straight parallel; four units maximum in master slave.

Overshoot:
No overshoot at turn-on, turn-off or power failure.

Overvoltage Protection:
Now factory installed on all DCRB models.

Remote Shutdown:
Remote relay, transistor or logic switching can be connected to shutdown terminals on back of supply.

Cooling:
Convection cooled on 400 to 1800 watt models. Built-in fan on 2100-2700 watt models.

DCRB ACCESSORIES

Digital Programmer:
Available for all models in DCRB series. IEEE-488 interface to GPIB bus. Order Model 488 DAP.

Chassis Slide (Kit):
Available for all convection cooled models and fan cooled DCR 7-300B only. Consult factory.

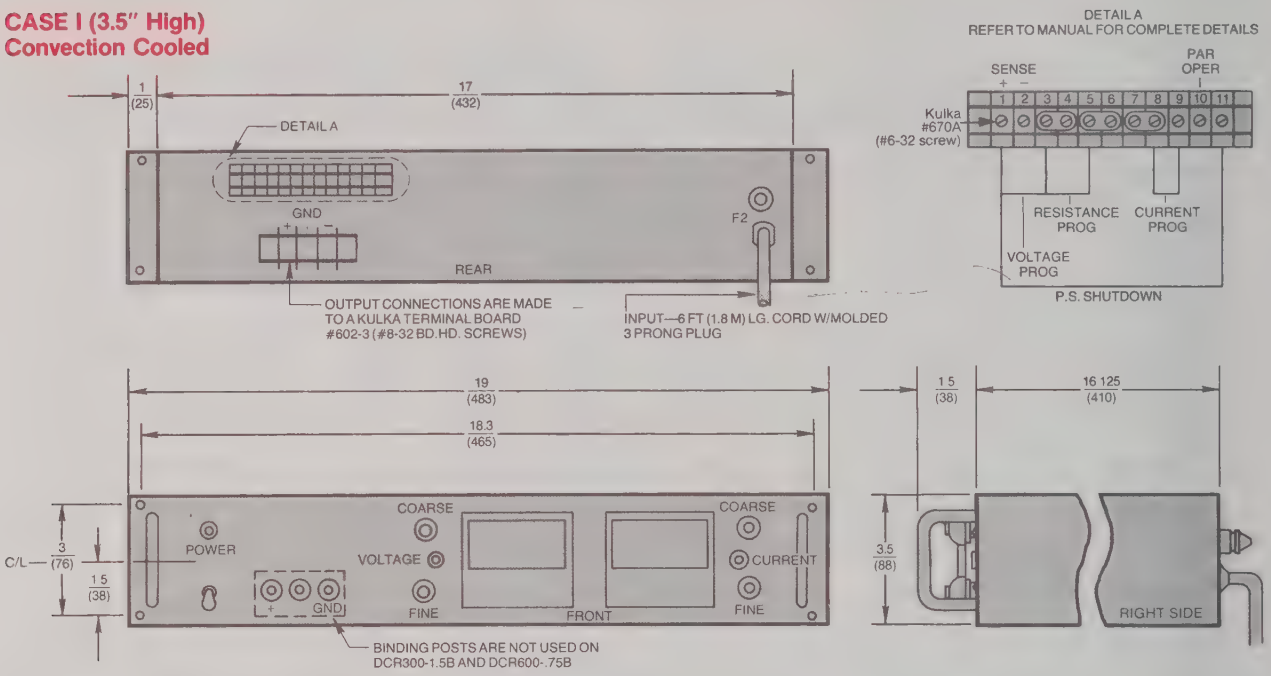
Model Specifications

Model	Current (A dc) 40°C	50°C	70°C	Input Current (A ac) at Standard Input Voltage	rms Ripple Constant Voltage (mV)	Constant Current (mA)	Resistive Programming Voltage Mode (Ohms/V)	Current Mode (Ohms/A)	Case	Efficiency (typ)
0-7V										
DCR 7-300B	300	225	150	27.5*	65	2800	1710	0.33	V	65%
0-10V										
DCR 10-40B	40	30	20	8.7	65	260	1200	10.0	I	61%
DCR 10-80B	80	60	40	16.0	65	520	1200	5.0	II	62%
DCR 10-120B	120	90	60	24.5	65	785	1200	3.3	III	62%
0-20V										
DCR 20-25B	25	19.3	13	9.4	65	82	600	16.0	I	71%
DCR 20-50B	50	37.5	25	20.0	65	125	600	8.0	II	69%
DCR 20-80B	80	60.0	40	30.0	65	260	600	5.0	III	70%
DCR 20-115B	115	86.5	58	26.5*	65	375	600	3.5	IV	70%
0-40V										
DCR 40-13B	13	9.8	6.6	9.8	90	30	300	30	I	71%
DCR 40-25B	25	19.3	13.0	16.0	90	56	300	16	II	79%
DCR 40-40B	40	30.0	20.0	26.8	90	90	300	10	III	78%
DCR 40-70B	70	55.0	40.0	29.6*	90	157	300	6	IV	77%
0-60V										
DCR 60-9B	9	7.0	5.0	9.7	125	19	200	46	I	75%
DCR 60-18B	18	13.3	8.6	19.0	125	38	200	22	II	81%
DCR 60-30B	30	23.3	16.5	27.0	125	63	200	16	III	84%
DCR 60-45B	45	35.8	26.5	29.0*	125	93	200	9	IV	80%
0-80V										
DCR 80-6B	6	4.7	3.3	8.3	150	12	150	68	I	77%
DCR 80-12B	12	9.3	6.6	15.0	150	23	150	33	II	83%
DCR 80-33B	33	26.5	20.0	27.2*	150	61	150	12	IV	81%
0-150V										
DCR 150-3B	3	2.4	1.7	8.2	300	6	80	134	I	74%
DCR 150-6B	6	4.7	3.3	15.5	300	12	80	66	II	84%
DCR 150-12B	12	9.3	6.6	27.0	300	24	80	33	III	84%
DCR 150-18B	18	14.0	10.0	27.0*	300	36	80	22	IV	83%
0-300V										
DCR 300-1.5B	1.5	1.2	0.8	8.9	700	4	40	270	I	74%
DCR 300-3B	3.0	2.3	1.7	15.7	700	7	40	133	II	82%
DCR 300-6B	6.0	4.7	3.3	27.0	700	14	40	66	III	84%
DCR 300-9B	9.0	7.3	5.5	27.4*	700	21	40	44	IV	83%
0-600V										
DCR 600-.75B	0.75	0.6	0.4	8.9	1200	2	20	530	I	74%
DCR 600-1.5B	1.5	1.2	0.8	15.2	1200	3	20	266	II	86%
DCR 600-3B	3.0	2.3	1.7	27.4	1200	6	20	133	III	86%
DCR 600-4.5B	4.5	3.5	2.5	26.8*	1200	9	20	89	IV	85%

Specifications subject to change without notice.
* 208V ac single phase input (all other models 115V ac input).

DCRB Series
Dimensional Drawings

CASE I (3.5" High)
Convection Cooled

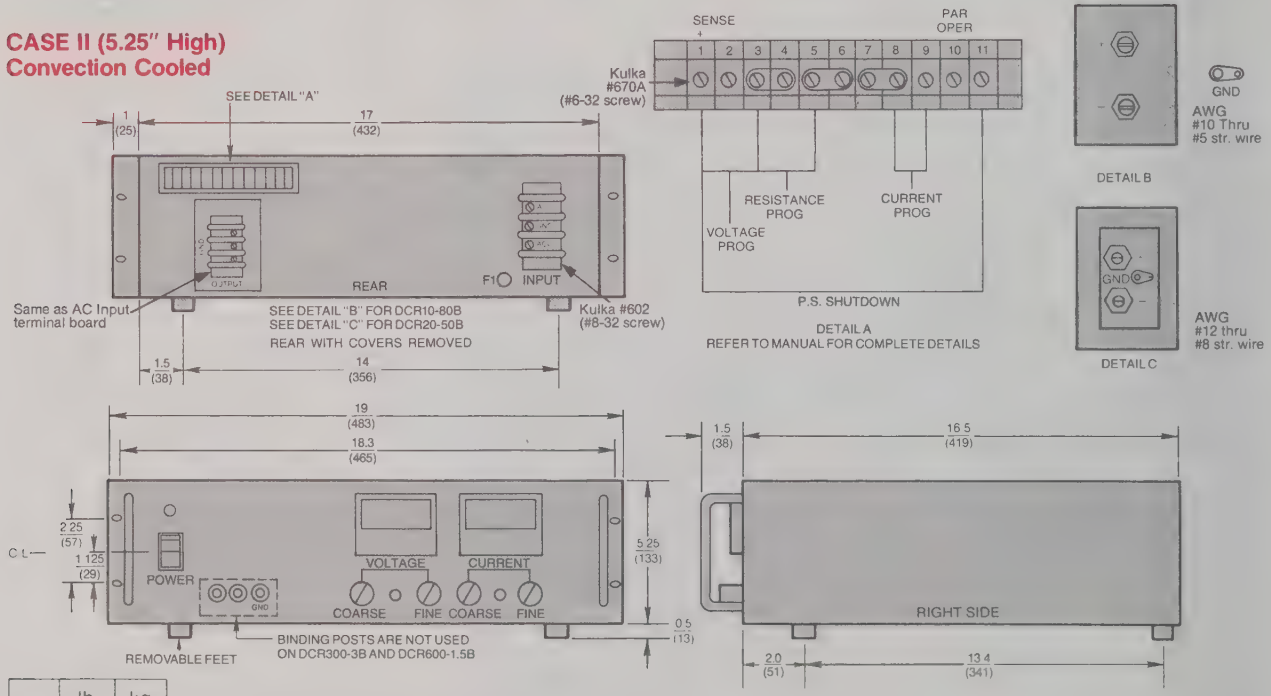


Wt.	lb	kg
	40	18.1

Note: Slide-rail option available.

Note: All dimensions are in inches (mm)

CASE II (5.25" High)
Convection Cooled



Wt	lb	kg
	70	31.7

Note: Slide-rail option available. Note: All dimensions are in inches (mm)

SORENSEN
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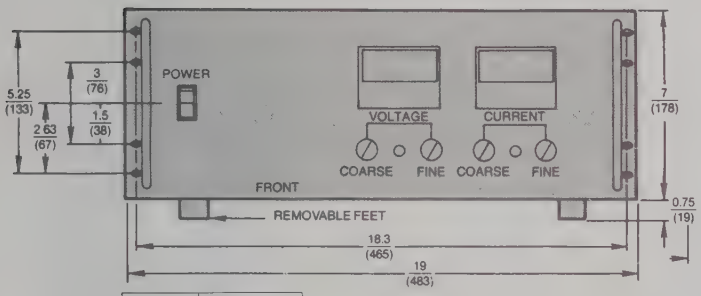
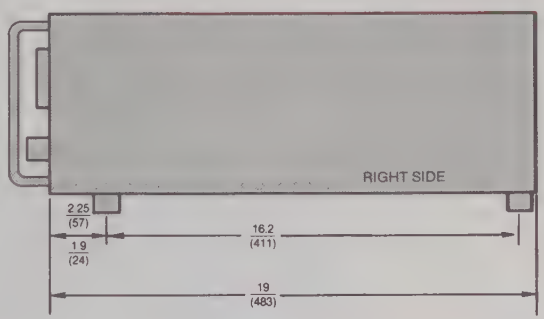
CASE III (7" High) Convection Cooled

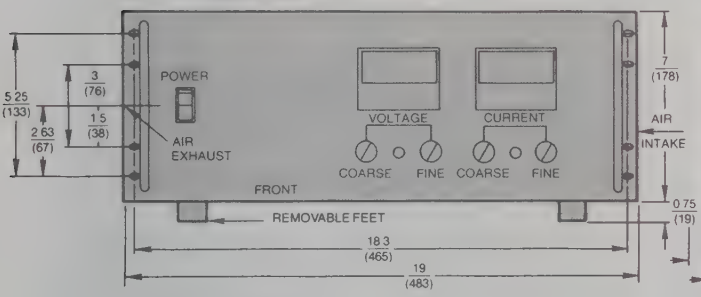


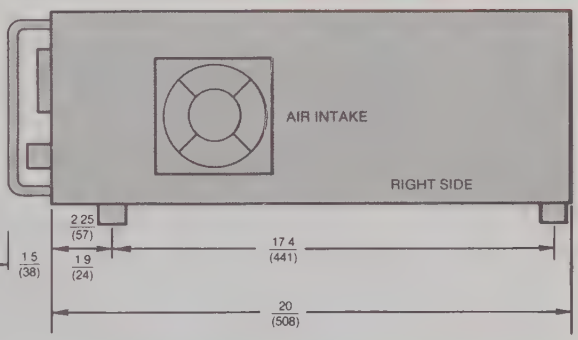


CASE	Weight lb.	Weight kg.
III	90	40.8

Note: Slide-rail option available.

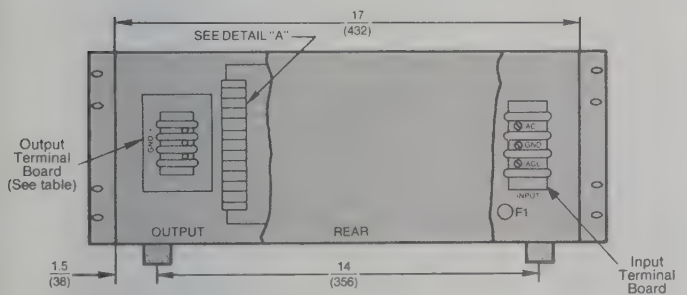
CASE IV (7" High) Fan Cooled



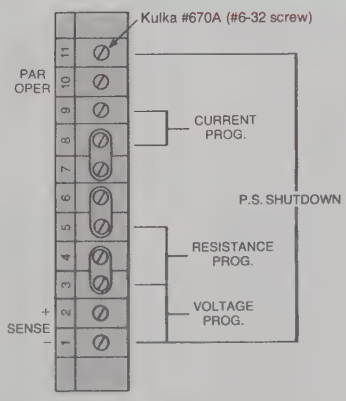


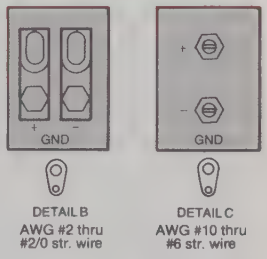
CASE	Weight lb.	Weight kg.
IV	130	58.9

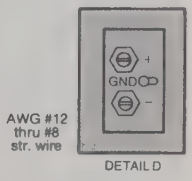
CASE III & IV REAR TERMINAL DETAILS



Note: All dimensions are in inches (mm)





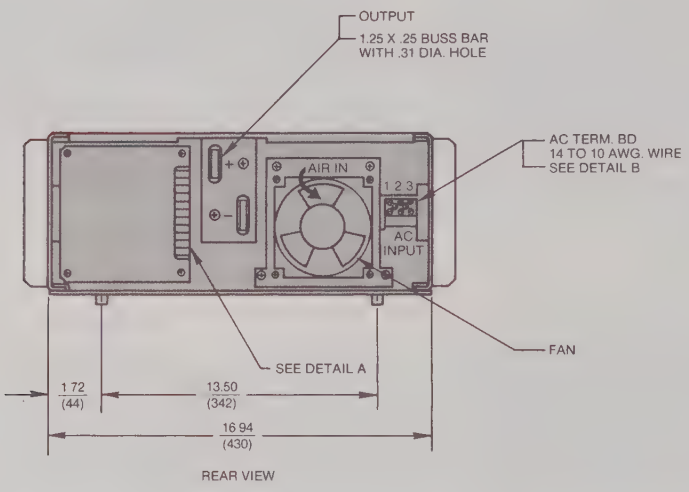


Input/Output Terminal Data

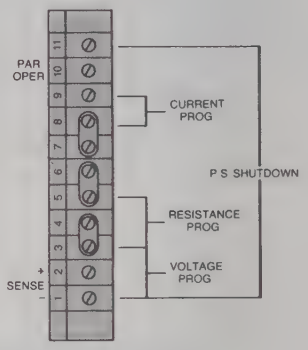
Terminal	Model	CASE III	Model	Case IV
AC		Kulka 602 (#8-32 screw)		Kulka 603 (#10-32 screw)
DC	DCR 10-120B	See Detail B	DCR 20-115B	See Detail B
DC	DCR 20-80B	See Detail B	DCR 40-70B	See Detail C
DC	DCR 40-40B	See Detail D	DCR 60-45B	See Detail D
DC	All others:	Kulka 602 (#8-32 screw)	All others:	Kulka 603 (#10-32 screws)

DCRB Series
Dimensional Drawings

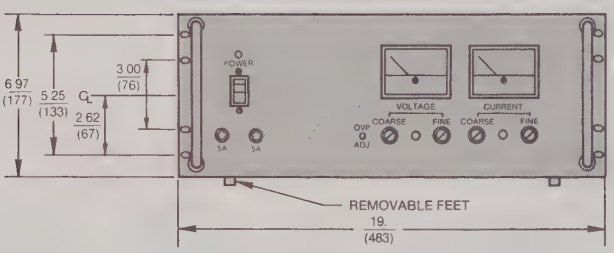
CASE V (7" High)
Fan Cooled



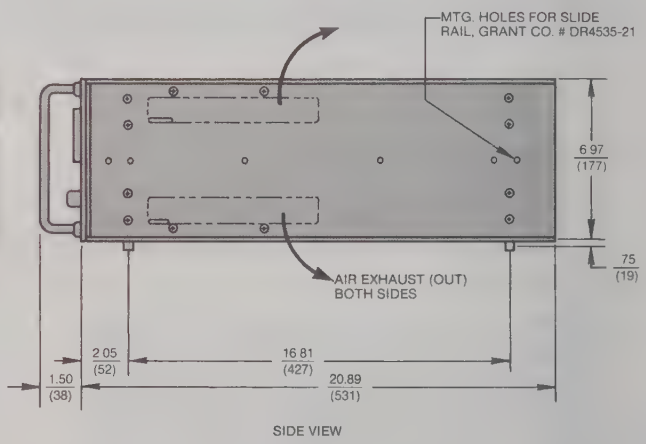
REAR VIEW



DETAIL "A"
REFER TO MANUAL FOR COMPLETE DETAILS



FRONT VIEW



SIDE VIEW

Wt.	lb.	kg.
	150	68

Note: All dimensions are in inches (mm)

SORENSEN
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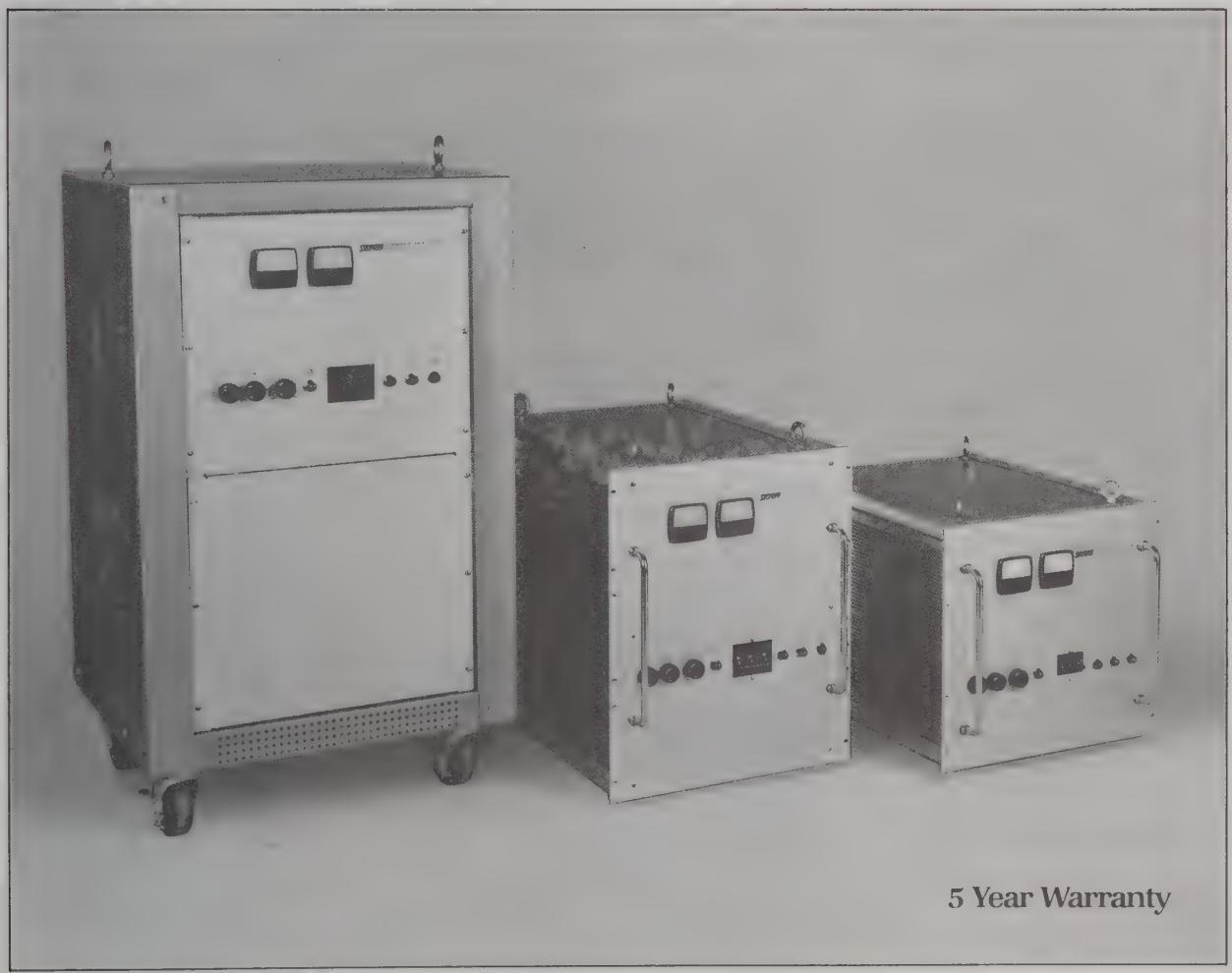
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

SORENSEN

High Power Three Phase Input Laboratory and Industrial Power Supplies DCRA Series

- 11 models in five voltage ranges, from 0-20V dc to 0-600V dc, with power levels from 5kW to 20kW
- 208V ac three phase input standard on 5kW models. 460V ac, three phase input standard on all others
- 50/60 Hz operation
- Optional input voltages available for 208/230/390/415V ac three phase operation
- Remote voltage or resistance programming in voltage or current modes
- Adjustable Current Limiting (overload/short circuit protection) with automatic recovery
- Excellent voltage or current regulation with automatic crossover
- Overvoltage protection available (except on 20kW models)
- 5 year warranty

The DCRA series incorporates a 3 phase input SCR controlled regulator producing high efficiency and fully adjustable output power.



DCRA Series
Specifications

DC OUTPUT
CONSTANT VOLTAGE MODE
Voltage Regulation:
0-20V dc to 0-40V dc models
Line and load combined:
0.2% or 30mV, whichever is greater

0-150V dc to 0-600V dc models
Line and load combined:
0.2% or 240mV, whichever is greater

Temperature Coefficient:
0.04%/°C of E_o max.

Resistive Programming:
See model specification chart.

Voltage Programming:
Consult local sales office or factory.

Stability:
0.1% E_o max for 8 hours after 30 minute warm-up.

Remote Sensing:
3V maximum drop per load lead but not to exceed 10% of E_o max.

Transient Response:
40ms (typical) to return to ±1% band for a step load change. 50% to 100% or 100% to 50% of full load. (20V models ±2% band.)

CONSTANT CURRENT MODE
Current Regulation:
0.4% I_o max. line and load combined.

Temperature Coefficient:
0.2%/°C. of I_o max.

Current Programming:
See model specification chart.

Stability:
0.5% of I_o maximum for 8 hours after 30 minute warm-up.

AC INPUT
Voltage:
187-229V ac three phase for 5kW models. 414-506V ac three phase for 10 and 20kW models.

Voltage Options:
Optional inputs available.
See page 5.17.

Frequency:
57-63 Hz all models.
49-63 Hz for 5kW models only.
49-63 Hz for 380/415V operation only on 10kW and 20kW models.

OPERATING DATA
Efficiency:
66-82% depending on model.

Series Operation:
200V dc maximum (150 and 300V models, two in series).

Parallel Operation:
Direct paralleling of any number of units.

Overvoltage Protection:
Optional adjustable crowbar protection available on all models except DCR 20-1000A and DCR 40-500A. Add suffix M5 to model number.

Ambient Operating Temperature Range:
0 to + 70°C

Storage Temperature Range:
–40°C to +85°C.

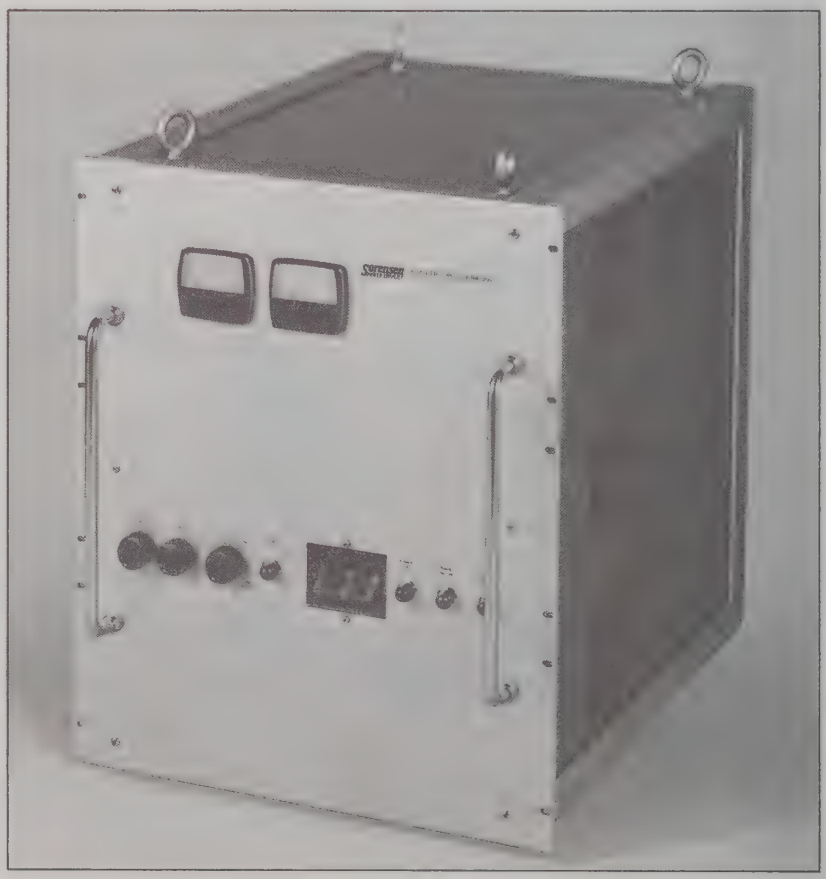
Cooling:
Forced air.

DCRA ACCESSORIES
Cabinet Style Side enclosures:
Available for all models with 17.5 inch (445 mm) and 22.75 inch (578 mm) front panel heights. Specify Kit CSE. Consult local sales representative for the following accessory pricing data.

Casters:
Standard on models DCR 20-1000A and DCR 40-500A. Available as option on all other models. Specify Kit CH.

Step Down Input Transformer:
380/415/460V ac three phase to 208/230V ac three phase @ 8kW for models DCR 20-250A, DCR 40-125A, DCR 150-35A, DCR 300-18A. Specify ST 101.

Digital Programmer:
Available for all models in DCRA series. IEEE-488 interface to GPIB bus. Order Model 488 DAP.



Model Specifications

Model	Current (A dc) 40°C	50°C	70°C	rms Ripple Constant Voltage (mV)	rms Ripple Constant Current (mA)	Resistive Programming Voltage Mode (Ohms/V)	Resistive Programming Current Mode (Ohms/A)	Case	Input Line Current[1]	Efficiency (typ)
0-20V										
DCR 20-250A	275	250	165	160	2000	160	0.6	I	37	66%
DCR 20-500A	550	500	330	160	4000	160	0.3	II	29	70%
DCR 20-1000A	1100	1000	660	160	8000	160	0.15	III	60	74%
0-40V										
DCR 40-125A	138	125	82.5	160	562.5	80	1.2	I	35	72%
DCR 40-250A	275	250	165	160	1125	80	0.6	II	27	75%
DCR 40-500A	550	500	330	160	2250	80	0.3	III	60	79%
0-150V										
DCR 150-35A	38.5	35	23	500	140	20	4.3	I	35	77%
DCR 150-70A	77.0	70	47	500	280	20	2.2	II	27	81%
0-300V										
DCR 300-18A	19.8	18	12	1000	72	10	8.3	I	35	78%
DCR 300-35A	38.5	35	23	1000	140	10	4.3	II	27	82%
0-600V										
DCR 600-18A	19.8	18	12	2000	72	5	8.3	II	27	81%

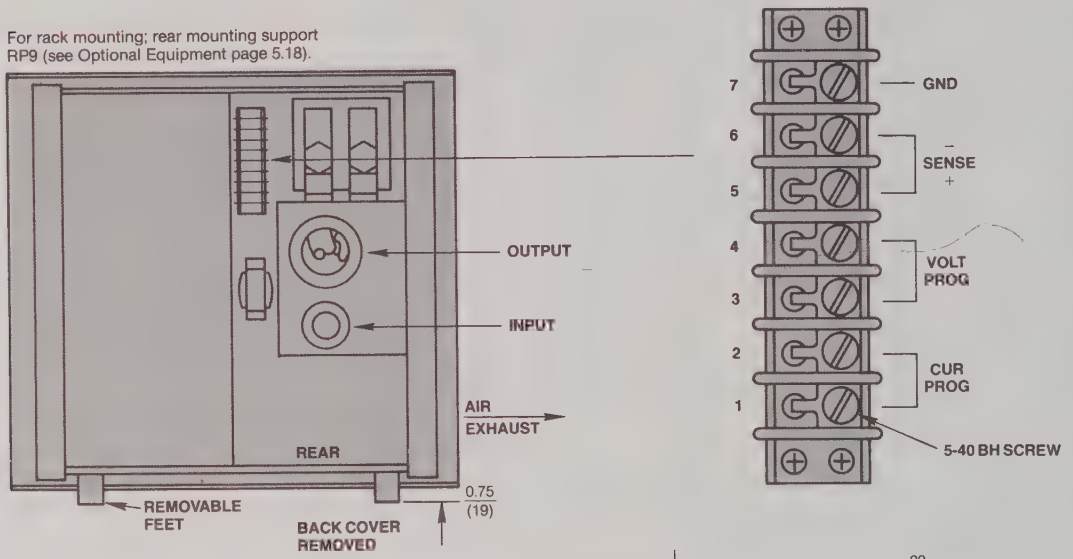
Factory installed OVP option: Available on all models except DCR20-1000A and DCR40-500A. To order, add suffix M5 to model number. Example: DCR20-250AM5. Consult local sales representative for price.

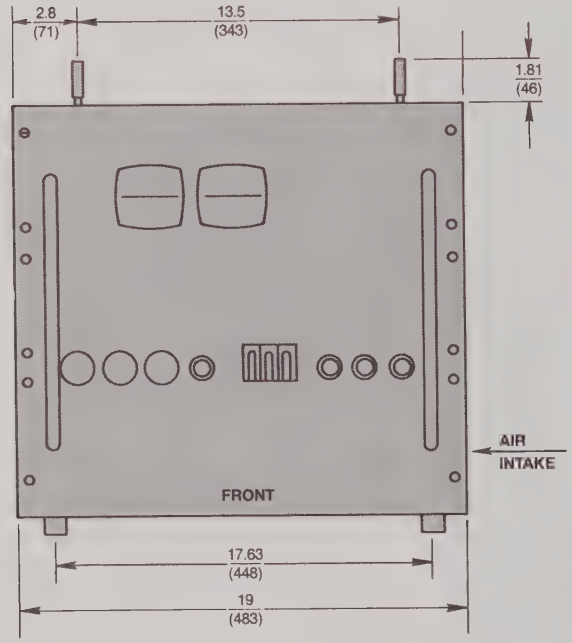
[1]AC amps per phase at standard input voltage (per table on page 5.17).

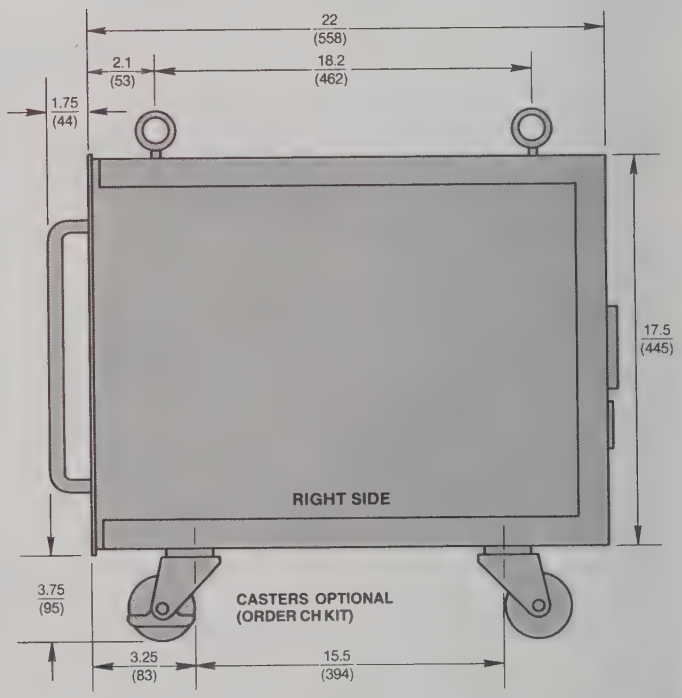
DCRA Series
Dimensional Drawings

CASE I

For rack mounting; rear mounting support RP9 (see Optional Equipment page 5.18).







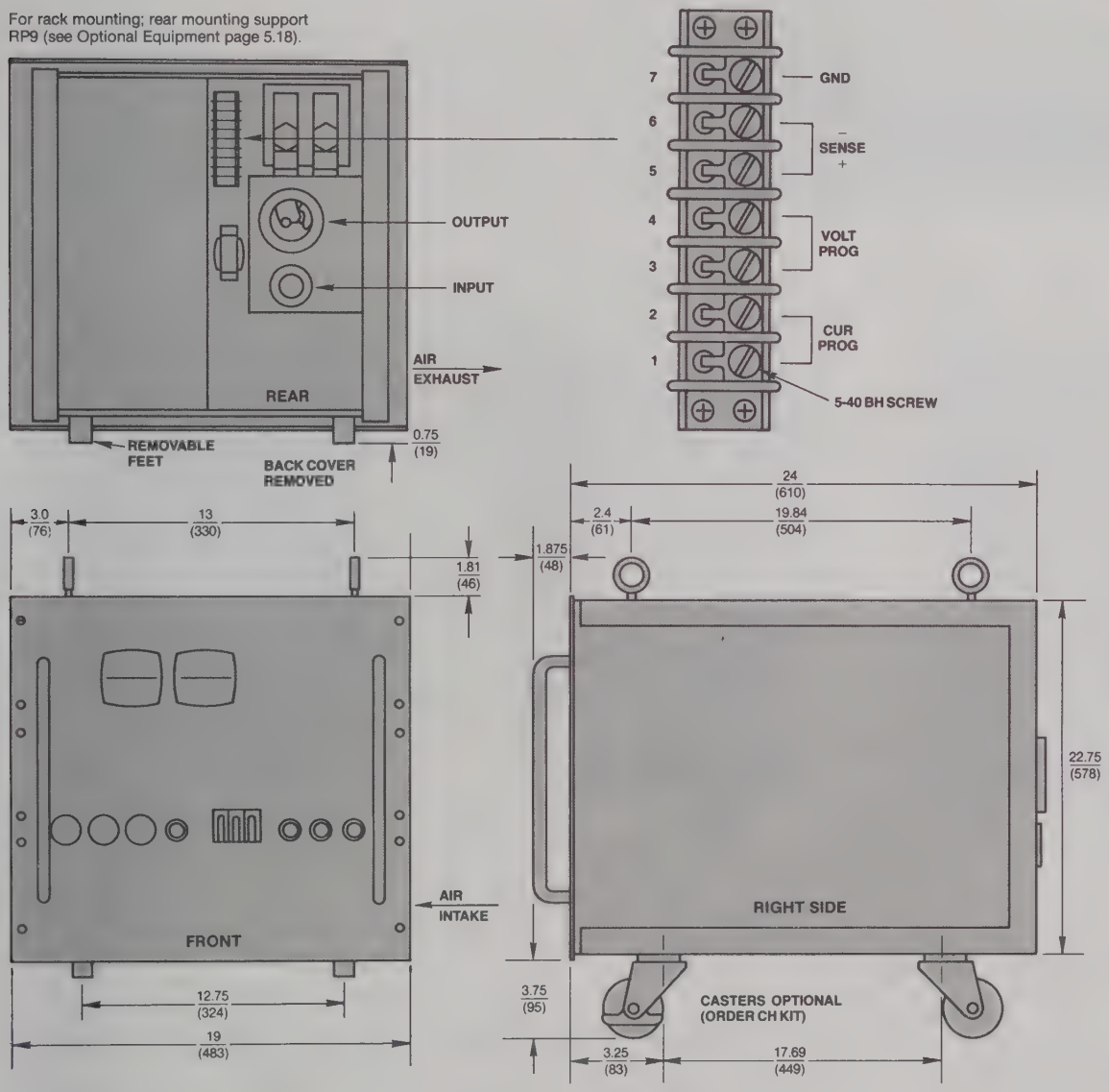
Input Terminals:	Model	Weight lb.	Weight kg.	Output Terminals
4 terminal barrier strip with 10-32BH Screws	**DCR 150-35A**	309	140	Jones' Barrier Terminal
	DCR 300-18A	318	144	Blocks/10-32BH Screws
Cabinet side enclosures optional for all models (order CSE kit)	**DCR 20-250A**	309	140	Penn Union #ZE34
	DCR 40-125A	315	143	post lug terminals for 1/0 to 350 MCM

Note: All dimensions are in inches (mm)

SORENSEN RAYTHEON Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

CASE II

For rack mounting; rear mounting support RP9 (see Optional Equipment page 5.18).

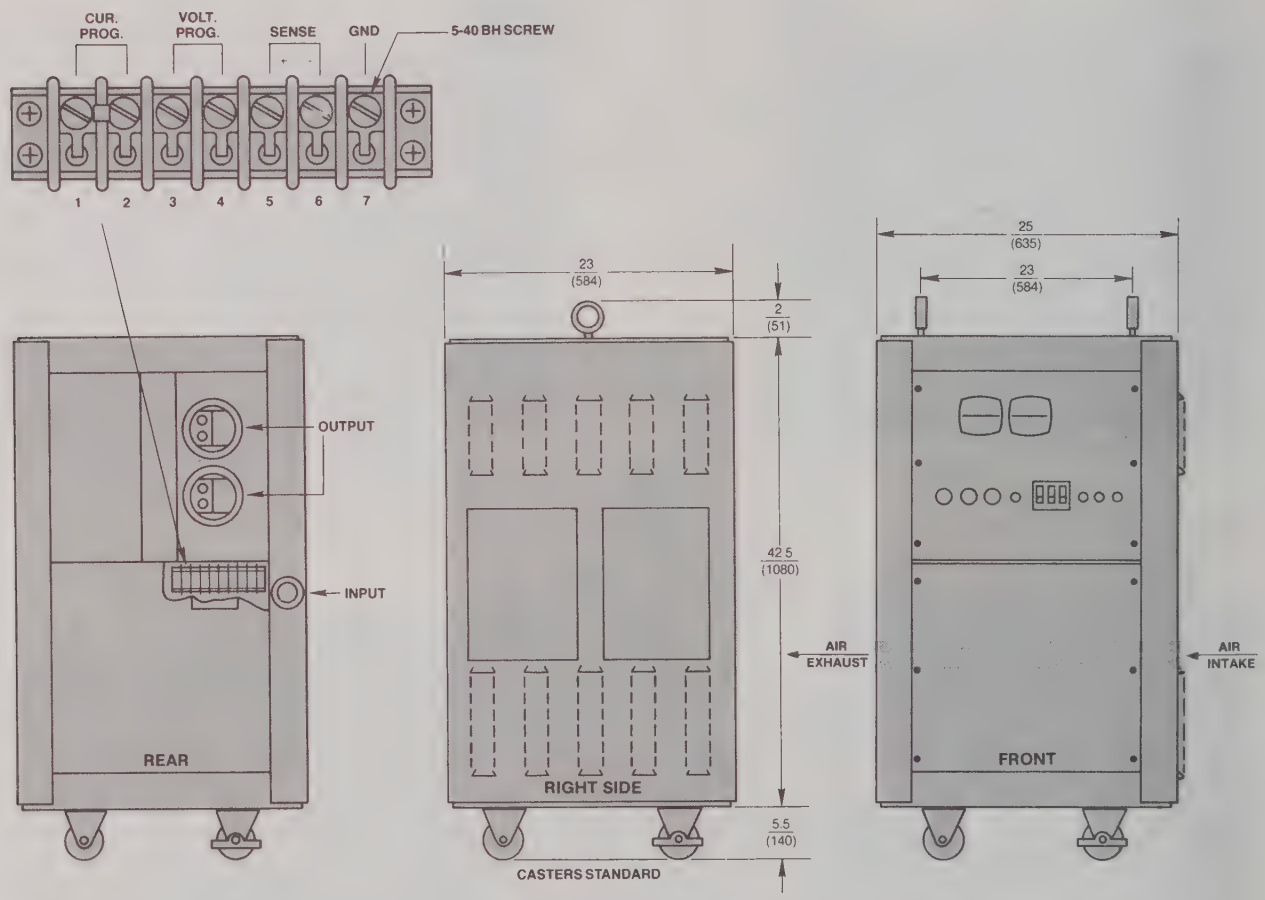


Input Terminals:	Model	Weight lb.	Weight kg.	Output Terminals
4 terminal barrier strip with 12-32BH Screws	**DCR 300-35A**	481	218	Jones' Barrier Terminal
	DCR 600-18A	481	218	Blocks/10-32BH Screws
	DCR 20-500A	481	218	Penn Union #Hex 21915 post lug terminals for 700MCM to 1000 MCM
	DCR 40-250A	481	218	Penn Union #ZE34 post lug terminals for 1/0 to 350 MCM
Cabinet side enclosures optional for all models (order CSE kit)	**DCR 150-70A**	481	218	Penn Union #ZE15 post lug terminals for #4 strd. to #1 strd.

Note: All dimensions are in inches (mm)

DCRA Series
Dimensional Drawings

CASE III



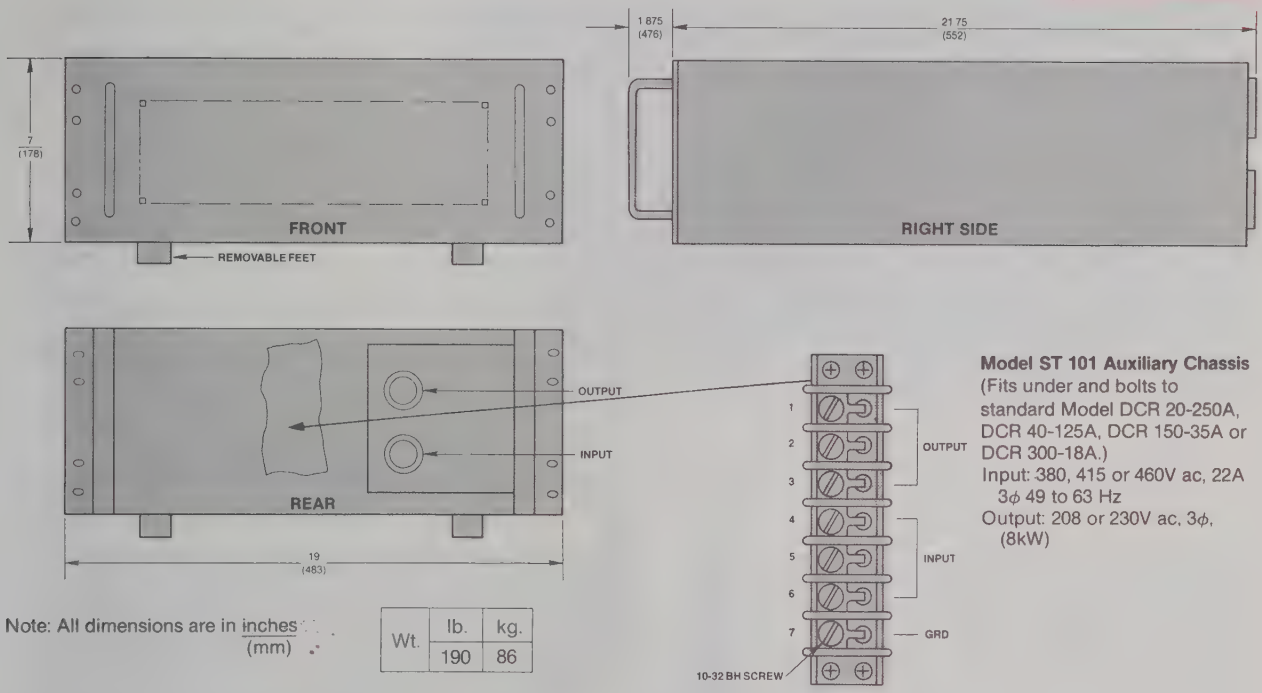
Input Terminals:	Model	Weight lb.	Weight kg.	Output Terminals
4 terminals barrier strip (DCR 40-500A - 12-32BH Screws, DCR 20-1000A - ¼-28BH Screws)	**DCR 20-1000A**	803	364	Penn Union #VL2-21925 post lug terminals. Each lug 700 MCM to 1000 MCM (2 wires)
	DCR 40-500A	803	364	Penn Union #Hex-21915 post lug terminals for 700 MCM to 1000 MCM

Note: All dimensions are in inches (mm)

SORENSEN RAYTHEON Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

Dimensional Drawings

ST 101 CHASSIS



Model ST 101 Auxiliary Chassis
(Fits under and bolts to standard Model DCR 20-250A, DCR 40-125A, DCR 150-35A or DCR 300-18A.)
Input: 380, 415 or 460V ac, 22A 3ϕ 49 to 63 Hz
Output: 208 or 230V ac, 3ϕ, (8kW)

Note: All dimensions are in inches (mm).

Wt.	lb.	kg.
	190	86

Factory Input Voltage Modifications

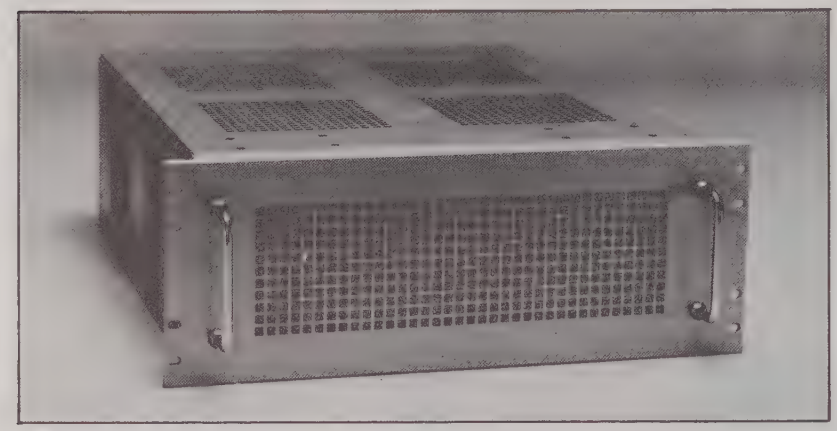
Model	187-229V	207-253V	342-418V (Volts, Three Phase)	390-440V	414-506V
0-20V					
DCR 20-250A	Standard	M3	N/A[6]	N/A[6]	N/A[6]
DCR 20-500A	M1	M3	M6[3]	M8	Standard
DCR 20-1000A	N/A	N/A	M6[4]	M8[5]	Standard
0-40V					
DCR 40-125A	Standard	M3	N/A[6]	N/A[6]	N/A[6]
DCR 40-250A	M1	M3	M6[3]	M8	Standard
DCR 40-500A	N/A	N/A	M6[4]	M8[5]	Standard
0-150V					
DCR 150-35A	Standard	M3	N/A[6]	N/A[6]	N/A[6]
DCR 150-70A	M1	M3	M6[3]	M8	Standard
0-300V					
DCR 300-18A	Standard	M3	N/A[6]	N/A[6]	N/A[6]
DCR 300-35A	M1	M3	M6[3]	M8	Standard
0-600V					
DCR 600-18A	M1	M3	M6[3]	M8	Standard

[3]Derate output voltage range by 10%. [4]Derate output voltage range by 25%. [5]Derate output voltage range by 7%.
[6]*Modification* not available. Specify *optional* step down transformer (see accessories) ST101.
Note: To specify, add modification suffix to model number. Example: DCR 40-250A M8. Consult local sales representative for pricing data.

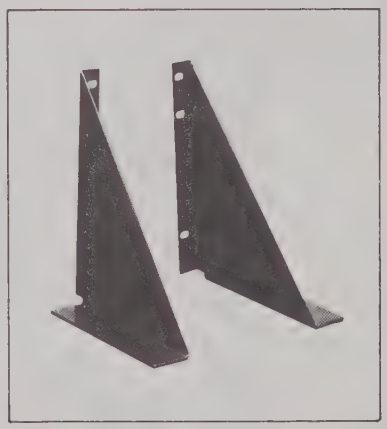
Field Input Voltage Modifications

Alternatively where applicable customer may perform field modification without voiding warranty. (See instruction manual for simple transformer tap changes.)

DCRA Series
Optional Equipment

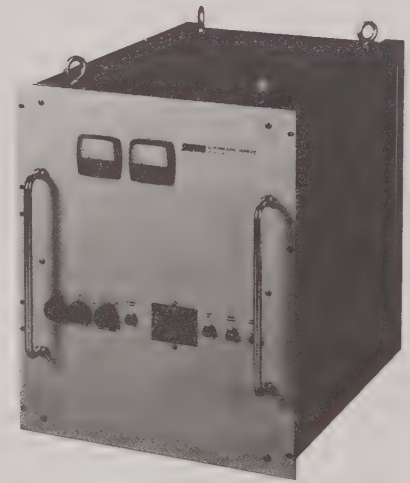


DCRA auxiliary three phase, stepdown input transformer. (380/415/460V ac to 208/230V ac @ 8kW). ST 101 (see drawing on page 5.17).

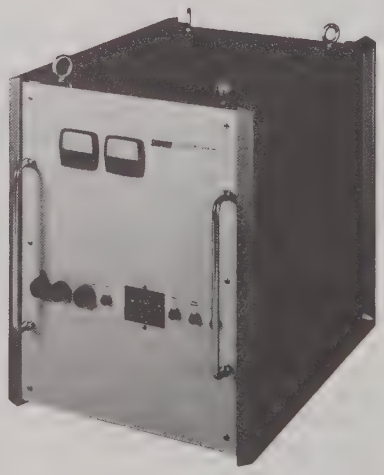


DCRA Rear Mounting Support. Kit RP9 (For Rack Mounting)

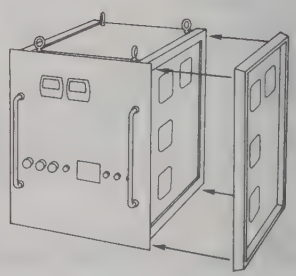
(Below)
CABINET SIDE ENCLOSURE (CSE). For self-contained use the CSE protects personnel from sharp edges and the unit from side damage. The CSE Kit consists of two heavy duty enameled metal enclosures and the necessary hardware



DCRA before CSE installation.



DCRA with CSE Kit, installed.



SORENSEN
RAYTHEON
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

SORENSEN

Bench, Lab, Test and System High Speed Programmable Power Supplies QRD Series

- 7 models in five voltage ranges from 0-15V dc to 0-60V dc with current levels from 0.75A to 4A
- 115V ac single phase input standard; 220/230V ac optional
- Standard and high speed programming modes
- 50/440 Hz operation without derating
- High speed programming by voltage or resistance in voltage or current modes
- Voltage regulation to ± 0.005%
- Excellent voltage or current regulation with automatic crossover
- Adjustable Current Limiting with automatic recovery
- Coarse and fine voltage and current output controls standard.
- No overshoot at turn-on, turn-off or power failure
- 5 year warranty

The QRD series incorporates a linear pass design which provides high performance and high speed programming features.

QRD Series
Model Specifications

DC OUTPUT
CONSTANT VOLTAGE MODE

Voltage Regulation:
Line and load combined 0.01% or 1.5mV, whichever is greater.

Temperature Coefficient:
±0.015% + 200μV/°C.

Resistance Programming:
100 ohms per volt.

Voltage Programming:
1 volt/volt, 10mA drive.

Stability:
0.025% +1mV for 8 hours after 30 minute warm-up.

Remote Sensing:
1V maximum drop per load lead.

Transient Response:
50μs (70μs in high speed mode) to return to a bandwidth of ±10mV for a 0-100% or 100-0% step load change (typical).

CONSTANT CURRENT MODE

Current Regulation:
.02% + 500μA

Temperature Coefficient:
0.015% + 100μA/°C.

Current Programming:
Current programmable. See specification chart.

Stability:
0.1% + 0.5 mA for 8 hours after 30 minute warm-up.

HIGH SPEED PROGRAMMING MODE

Programming time (typical):
0-100% ΔE = 25μs
100-0% ΔE = 10μs
0-100% ΔI = 80μs
100-0% ΔI = 200μs

Ripple:
High speed specifications are twice those listed in model specs.

Maximum Capacitive Load:
0.02μF.

AC INPUT

Voltage:
105-125V ac single phase standard.

Voltage Options:
200-240V ac 210-250V ac selectable.

Frequency:
47-440Hz operation.

OPERATING DATA

Ambient Operating Temperature Range:
0 to + 70°C

Storage Temperature Range:
–40°C to +85°C.

Resolution:
0.01% of E_o max. and 0.015% of I_o max. with standard controls.

Series Operation:
200V dc maximum.

Parallel Operation:
Master-slave up to three units maximum. Straight paralleling any number.

Overshoot:
No overshoot at turn-on, turn-off or power failure.

Overload/Short Circuit Protection:
Adjustable Automatic Current Limiting (ACL) with automatic recovery.

QRD ACCESSORIES

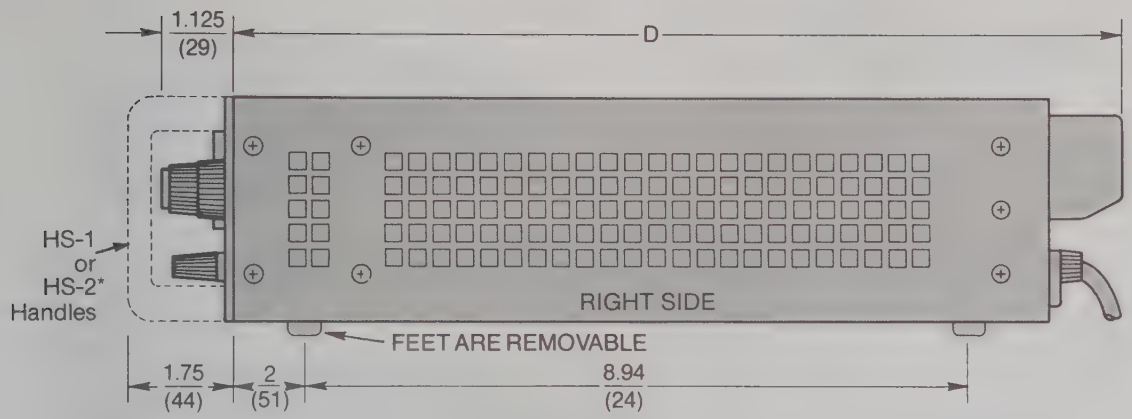
Overvoltage protection, front panel handles, rack adapters, IEEE-488 digital programmer.

Model	Output Current A dc 40°C	55°C	70°C	Ripple Constant Voltage (μV rms)	Constant Current (μA)	Remote Current Programming Ohms/A	Volts/A	AC Input Current (at 115V)	Case	OVP*
0-15V										
QRD 15-2	2.2	2.0	1.2	200	150	500	0.5	0.95A	I	VP1
0-20V										
QRD 20-4	4.4	4.0	2.4	200	400	250	0.25	2.3A	II	VP1
0-30V										
QRD 30-1	1.1	1.0	0.6	200	150	1000	1.0	0.95A	I	VP1
0-40V										
QRD 40-.75	0.83	0.75	0.45	200	150	1300	1.3	0.95A	I	VP1
QRD 40-2	2.2	2.0	1.2	200	300	500	0.5	2.3A	II	VP1
0-60V										
QRD 60-.5	0.55	0.5	0.3	200	150	2000	2.0	0.95A	I	VP3
QRD 60-1.5	1.65	1.5	0.9	200	300	670	0.67	2.3A	II	VP3

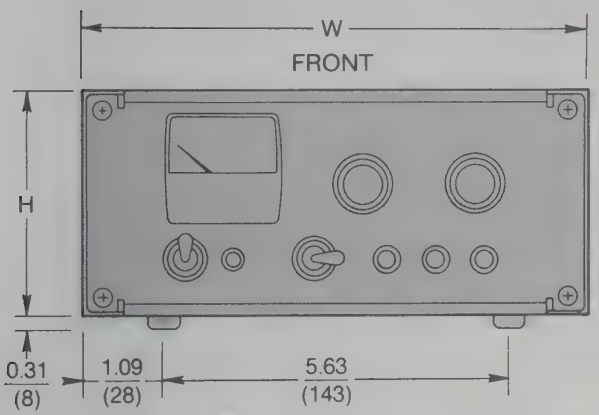
*For specifications see page 5.24 For rack mounting information see page 5.22.

Dimensional Drawings

CASE I & II

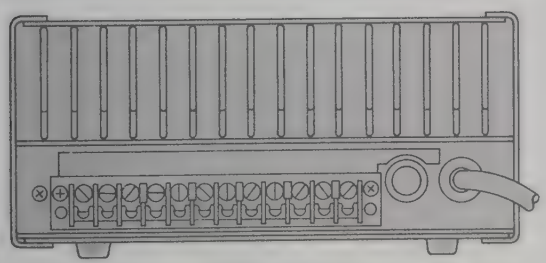


*HANDLES (ACCESSORY ITEM) See page 5.22.



Case	W Width	H Height	D Depth	Weight lb.	Weight kg.
I	8.18 (208)	3.46 (83)	12.75 (324)	12.5	5.7
II	8.19 (208)	5.22 (133)	13 (330)	19.5	8.8

Note: All dimensions are in inches (mm)



REAR

QRD Series
Rack Mounting Accessories and Optional Equipment

Accessories

Single and dual 19" adapters permit rack mounting a single QRD, or two units side by side. (includes chromed handles)

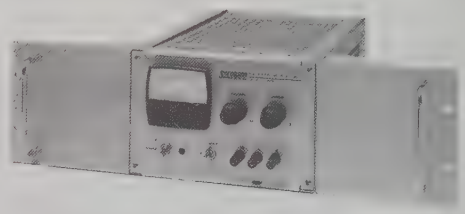
	Accessory No.
Single Mounting for 3½" high units	RP12
Single Mounting for 5¼" high units	RP13
Dual Mount for 3½" high units	RP14
Dual Mount for 5¼" high units	RP15

Handle sets for use with QRD Series Power Supplies

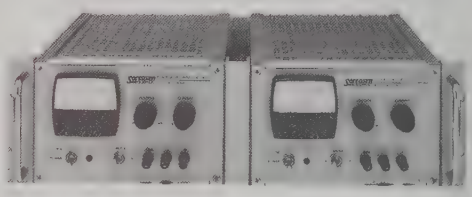
3½" high units	HS-1
5¼" high units	HS-2

2 channel digital-to-analog programmer, IEEE-488 interface to GPIB bus ..... 488 DAP

RP13



RP15



Options

Ten turn current control installed in place of standard coarse and fine control.
Resolution ≅ .025% Option No.

Linearity ± .25%	CC-1
Calibrated dial for 10 turn current control	D-1

Ten turn voltage control installed in place of standard coarse and fine control.
Resolution ≅ .015%

Linearity ± .25%	See chart below
Calibrated dial for 10 turn voltage control	D-2

HS-1

488-DAP

Model	QRD15-2	QRD20-4	QRD30-1	QRD40-.75	QRD40-2	QRD60-.5	QRD60-1.5
10 turn voltage control option #	VC -2	VC-3	VC-4	VC-5	VC-5	VC-6	VC-6

Note: When ordering option, specify after model no.
Example: QRD15-2 VC-2 D-2.

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SORENSEN

Overvoltage Protectors for QSA and QRD Series
OVP Models

- 4 models available to match each Sorensen power supply or instrument in the QSA and QRD Series.
- Fast response SCR crowbar action (10μs typical)
- Wide range trip voltage adjustment
- Output voltages reduce to 2.5V or less when tripped
- Temperature coefficient 0.5% of preset trip voltage/°C
- 5 year warranty

5 Year Warranty

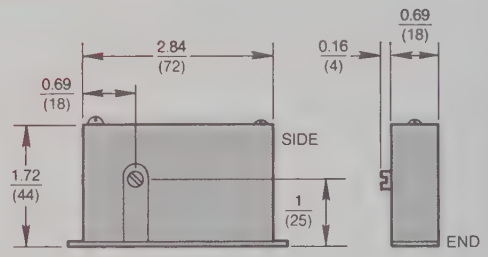
OVP Models
Overvoltage Protectors for QSA and QRD Series

OVP Series Specifications

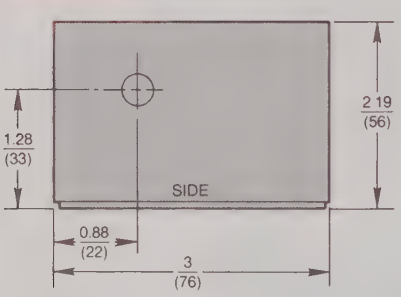
Power Supply	OVP Model
QSA 10-1.4	VP1
QSA 10-3.7	VP1
QSA 18-1.1	VP1
QSA 18-1.9	VP1
QSA 18-3.0	VP1
QSA 48-0.4	VP3
QSA 48-0.8	VP3
QSA 48-1.2	VP3
QSA 75-0.5	VP3
QSA 120-0.5	VP8
QSA 175-0.25	VP23
QSA 265-0.15	VP23
QRD 15-2	VP1
QRD 20-4	VP1
QRD 30-1	VP1
QRD 40-0.75	VP1
QRD 40-2	VP1
QRD 60-0.5	VP3
QRD 60-1.5	VP3

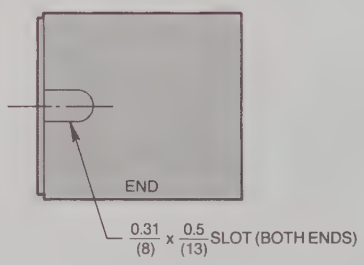
Model	VP1	VP3	VP8	VP23
Applied Voltage V dc (screwdriver trip adjustment)	3.5-50	3.5-100	3.5-150	140-350
Loading (mA)	10	10	10	25
Max Crowbar (tripped current)	4.4A	4.4A	4.4A	0.3A

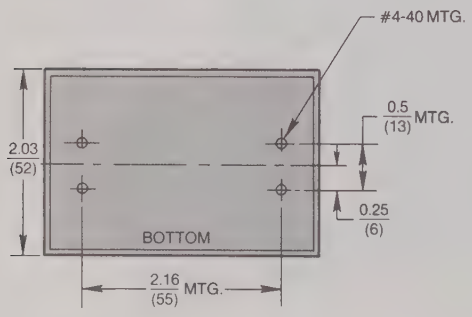
Model VP1, VP3 & VP8



Model VP23







Note: All dimensions are in $\frac{\text{inches}}{\text{mm}}$

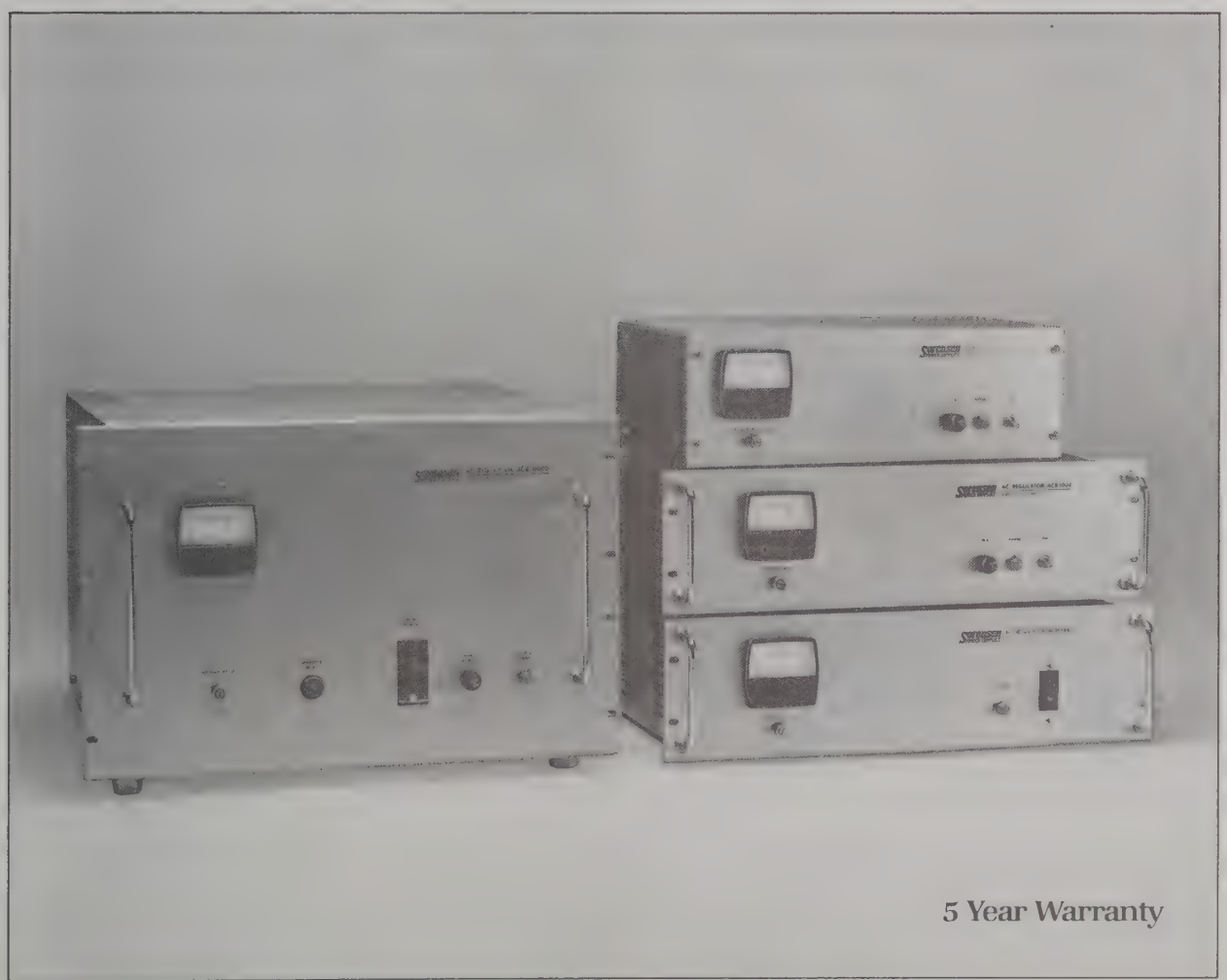
SORENSEN
RAYTHEON
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

SORENSEN

Solid State
AC Line Voltage Regulators
ACR Series

- 8 models, 95-130V ac single phase operation with power levels 0.5kVA to 15kVA
- High efficiency 84-95% depending on model
- Fast response time
- 50/60 Hz operation without derating
- Insensitive to line frequency deviations
- Adjustable output voltage
- Remote programming
- Remote sensing
- Electronic Current Limiting permits operation with tungsten lamp or small motor loads
- Three phase operation by multi-unit configuration
- 5 year warranty

The ACR series features a single phase input SCR controlled regulator to provide high efficiency and precise AC power for critical power requirements.



5 Year Warranty

ACR Series
Specifications

OUTPUT

Output Voltage:
110-120V ac single phase, adjustable.

Regulation:
±0.1% line or load on models 0.5kVA to 3kVA for full load change or ±10% line voltage change.
±0.15% line or load for 5kVA and over.

Resolution:
0.05% of output voltage (E_O).

Power Factor:
Unity to zero lag. On 7.5kVA and larger models, input voltage range is reduced to 100-130V ac for power loads below 0.7 lagging.

Harmonic Distortion:
3% maximum measured at nominal 60 Hz or 50 Hz (introduced by regulator).

Response Time:
30ms (50ms for 0-7.5kVA and over)

Stability:
0.05% for 8 hours after 30 minute warm-up time.

Remote Sensing:
1.5V maximum drop per load line.

Current Limiting:
Factory set at 120% of rated current. Consult manual for details on heavy overloads and short-circuits.

Temperature Coefficient:
0.015% of E_O/°C, for models 0.5kVA to 3kVA.
0.03% of E_O/°C for 5kVA and over.

INPUT

Input Voltage Range:
95-130V ac single phase. Momentary input surges 91-142V ac single phase.

Frequency:
47-53 Hz or 57-63 Hz operation. Factory set for 57-63 Hz.

OPERATING DATA

Ambient Temperature Range:
0°C to +50°C.

Storage Temperature Range:
-40°C to + 85°C.

Efficiency:
84-95% depending on model.

Remote Programming:
10 ohms/volt.

Remote Sensing:
1.5V max. drop per load lead.

ACR ACCESSORIES

Rack mounting adapter:
19" (4826 mm), mounting adaptor for ACR 500. Add RP7 to model number and consult local sales representative for price.

Cabinet Style Side Enclosures:
For self-contained bench use. Kit available for 0-3kVA models and over. Add CSE to model number and consult local sales representative for price.

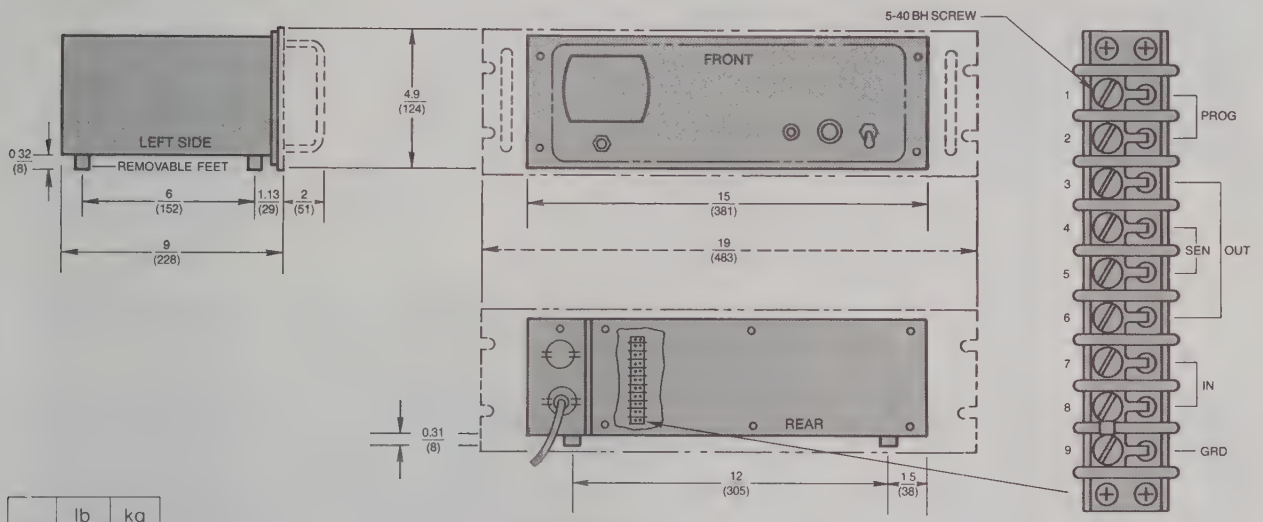
Model Specifications

Model	Output Power (kVA)	AC Input Current (Max)	Efficiency (Full VA) %	Case
ACR 500	0-0.5	7	84	I
ACR 1000	0-1	14	86	II
ACR 2000	0-2	26	88	III
ACR 3000	0-3	39	90	III
ACR 5000	0-5	63	92	III
ACR 7500	0-7.5	94	93	IV
ACR 10,000	0-10	123	94	IV
ACR 15,000	0-15	183	95	IV

RP7 (For use with ACR 500 only)

Specifications subject to change without notice.

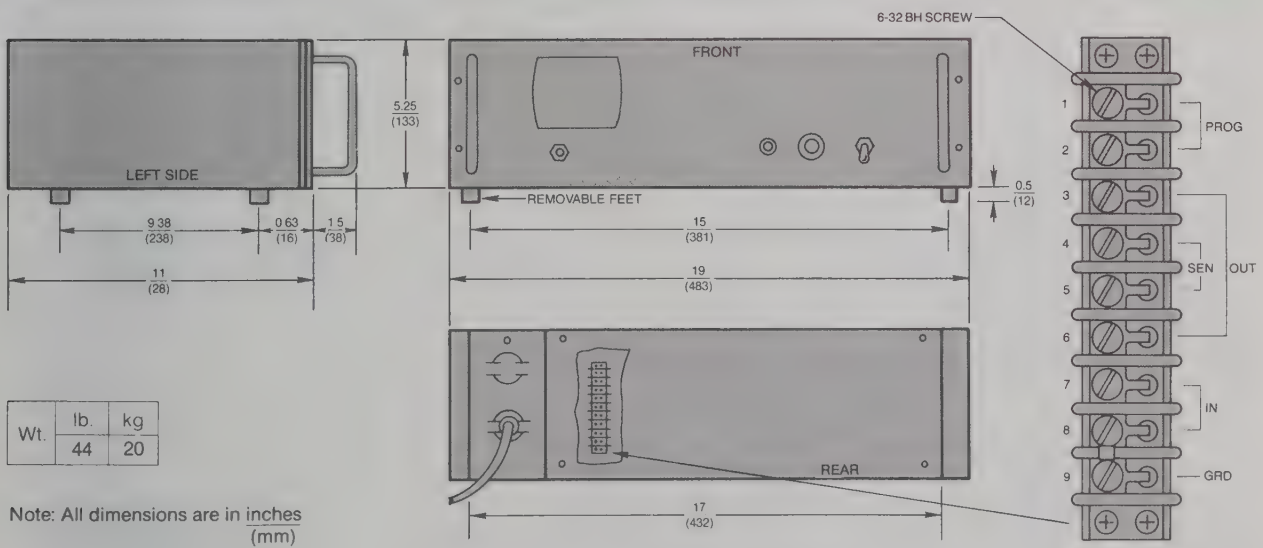
CASE I



Wt.	lb	kg
	29	13

OPTIONAL 19 INCH RACK
ADAPTER IS AVAILABLE FOR THIS MODEL.
ORDER ADAPTER #RP7. (SEE DOTTED LINES ABOVE)

CASE II

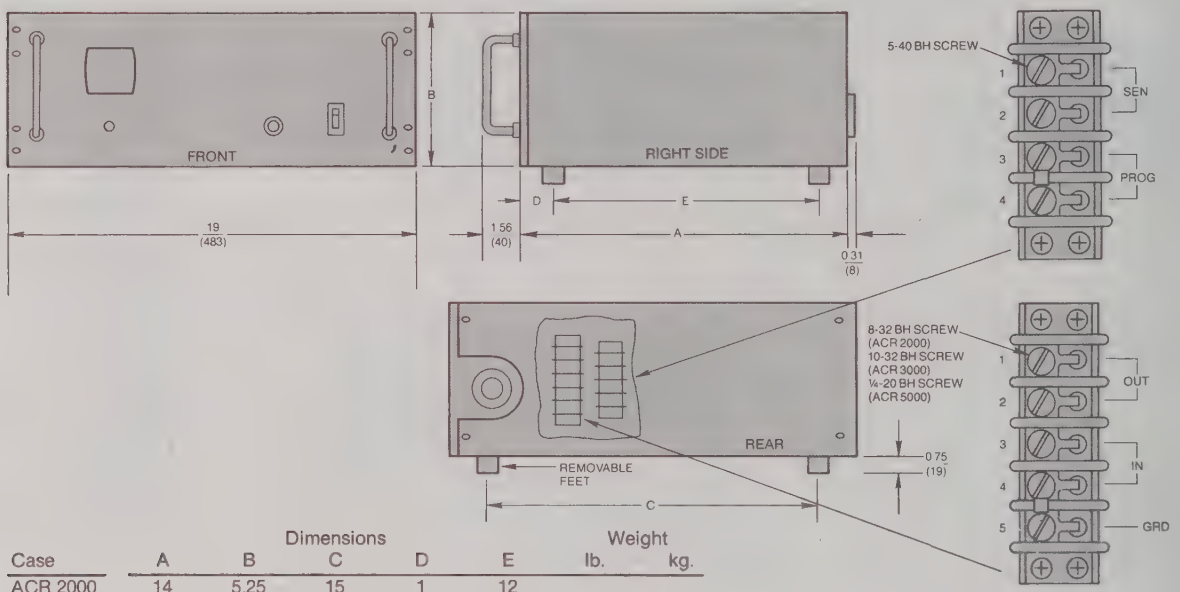


Wt.	lb.	kg
	44	20

Note: All dimensions are in inches (mm)

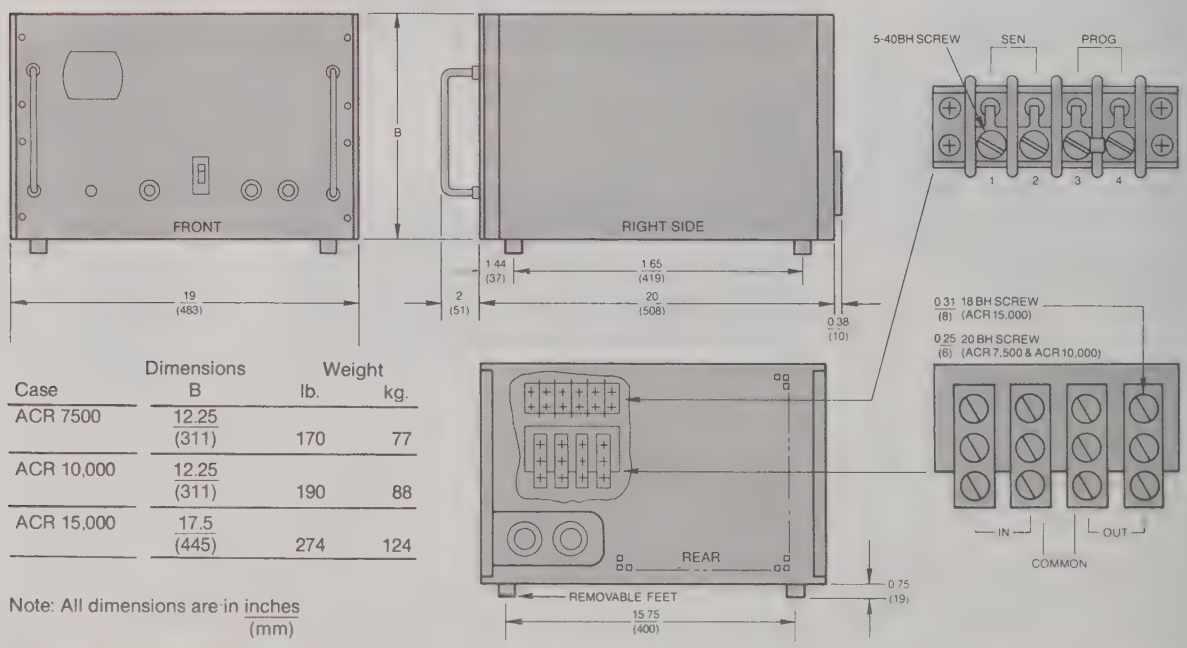
ACR Series
Dimensional Drawings

CASE III



Case	Dimensions A	B	C	D	E	Weight lb.	kg.
ACR 2000	14 (356)	5.25 (133)	15 (361)	1 (25)	12 (305)	64	29
ACR 3000	15 (381)	7 (178)	14.25 (214)	2 (51)	14.25 (362)	84	38
ACR 5000	20 (508)	7 (178)	14.25 (214)	2 (51)	14.25 (362)	143	65

CASE IV



Case	Dimensions B	Weight lb.	kg.
ACR 7500	12.25 (311)	170	77
ACR 10,000	12.25 (311)	190	88
ACR 15,000	17.5 (445)	274	124

Note: All dimensions are in inches (mm)

SORENSEN
RAYTHEON

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SORENSEN

2 Channel Digital-To-Analog Programmer 488 DAP Series

- Interfaces to GPIB Bus (per IEEE - 488/1978 Standard)
- Two independent channels: each channel 0 to 10V or 0 to 1V
- 3 digit programming resolution.
- For use with all Sorensen programmable power supplies
- Flag circuit available to sense if power supply output is not as programmed
- Can be used with most GPIB controllers
- ASCII data format (BCD)
- ± 0.5 LSD basic digital-to-analog conversion accuracy
- 5 year warranty

The primary application for the 488 DAP is in ATE. Other applications are process control, environmental testing and motor control.

5 Year Warranty

2 Channel 488 DAP Series
Specifications

AC INPUT
Voltage:
90-110V ac, 108-132V ac
198-242V ac, 216-264V ac
single phase selectable via voltage select card

Current:
0.5A @ 117V ac

Frequency:
49-440Hz

ANALOG OUTPUT
Voltage Ranges:
0-9.99V dc (in 10mV increments)
0-0.999V dc (in 1mV increments)
shipped as 9.99V. Internal link changes required for 0.999V.

Current:
15mA source
1.5mA sink

Pard:
(Combined ripple, noise and drift, dc to 1MHz)
< 2.0 mV rms

Temperature Coefficient:
< 100 PPM/°C

Accuracy:
9.99V range: ±15mV
0.999V range: ±1.5mV

Zero Offset:
±250mV max. (by insertion of internal link change, the positive offset may be increased to 5.2V. The maximum output remains 9.99V.)

Full Scale Adjust:
± 250mV max

Programming Time:
0.6ms min. (controller processing time must be added)

OPERATING DATA
Ambient Operating Temperature Range:
0 to + 70°C

Storage Temperature Range:
-55°C to +85°C.

Isolation:
The AC line, the digital input and both analog outputs are isolated from each other and the chassis to withstand a 1500V dc test.

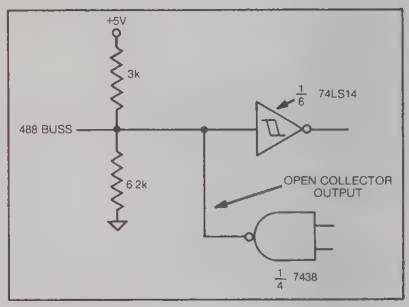
Cooling:
Convection cooled

Finish:
Textured blue thermal paint.

DIGITAL INPUT
Digital Interface:
The GPIB input/output connections are made on the front panel of the unit and conform to IEEE Standard 488/1978.

Functions Implemented:
L, AH, PP

Digital Input/Output:
TTL level, source/sink capability per IEEE-488/1978. Inputs Schmitt trigger buffered, outputs open collector devices. (See Figure.)



Data Format:
ASCII, 4 consecutive BCD data bytes: MSD, 2SD, LSD, 0/4. The last digit is used to set an auxiliary bit when required.

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2 Channel 488 DAP Series
Digital-To-Analog Programmer

Sorensen's 488 DAP is a two channel digital-to-analog (dc) converter designed to interface with the IEEE-488/1978 Standard data bus or General Purpose Interface Bus (GPIB). The 488 DAP functions (except for a limited Parallel-Poll capability) as a LISTENER on the bus (at any one or two legitimate addresses, switch selectable), with which it communicates via a 488 Standard connector. Data format is conventional ASCII, four BCD Bytes are required to load three significant figures of decimal voltage data for the digital-to-analog converter plus a bit for an auxiliary control line. Outputs of 0-9.99V dc or 0-0.999V dc are separately link selectable for each channel.

The digital inputs are Schmitt trigger buffered compatible with TTL levels. Source/sink capability is per IEEE-488/1978 Standard and the outputs are open collector devices.

Output is two flag bits (one per channel) available on bus lines D101-D108, (switch selectable) during Parallel-Poll. If used, this feature permits monitoring the conformity of the programmed supply's output with the digitally programmed value.

The 488 DAP functions on the GPIB with most GPIB-compatible devices and suitable Controllers such as Hewlett Packard 9825A Calculator, the Commodore PET Computer, and others. All Sorensen programmable power supplies can be controlled by the 488 DAP. Zero offset and scale factor adjustments are provided to trim the controlled supply's output.

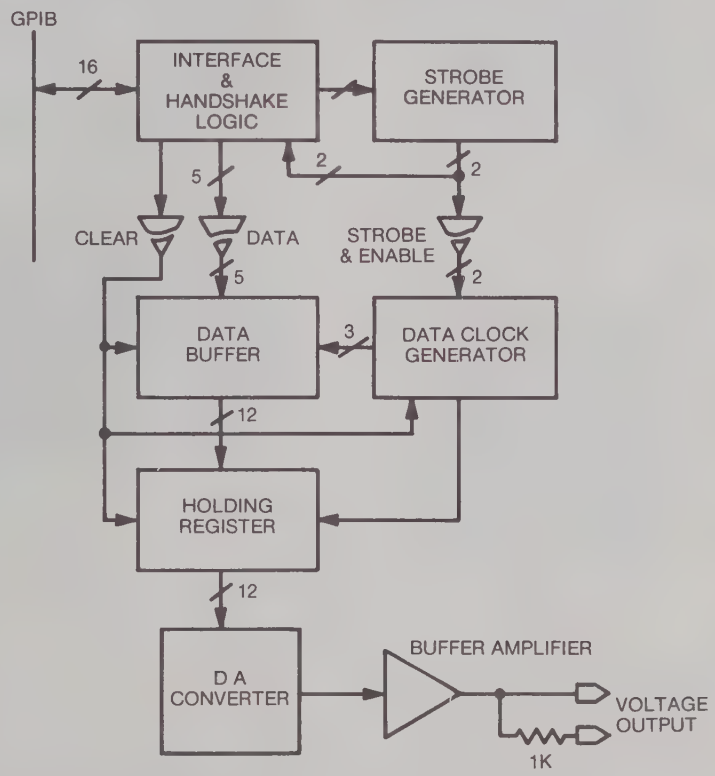
Typical Power Supply Programming Time

Series	0-E max	E max - 0
QRL	5 to 15μs	5 to 15μs
QRD	20 to 30μs	10 to 20μs
SRL	16 to 100ms	5 to 50ms
DCR-B	150 to 300ms	500 to 2000ms

Based on 50% load.

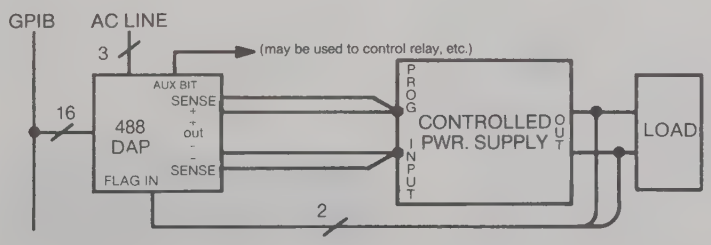
The 488 DAP's outputs can be used directly (and independently) as programmed sources, no intervening programmable supply being necessary.

The primary application for the 488 DAP is in Automatic Test Equipment. Other uses for the 488 DAP are in process control, environmental testing, motor control, and similar applications.



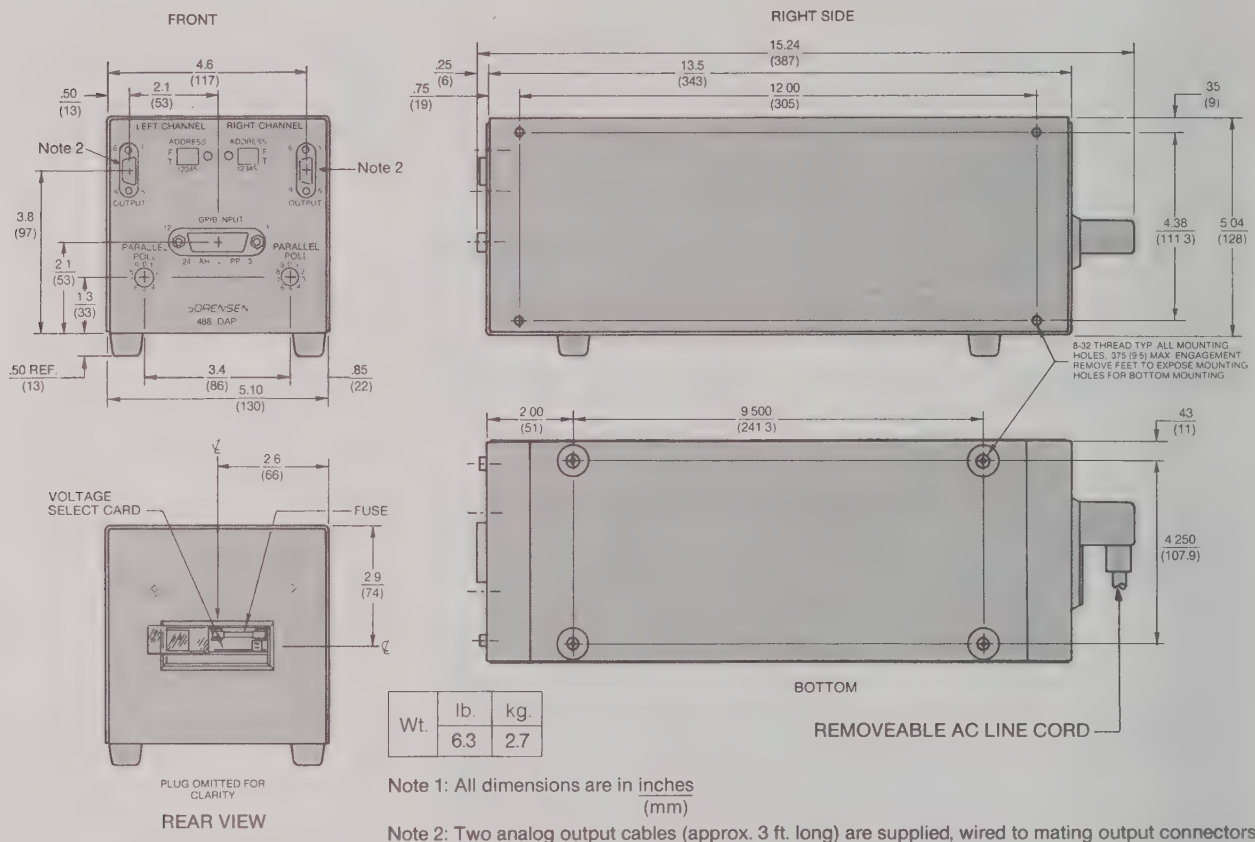
Simplified Block Diagram of 488 DAP (single channel shown)

Note: Auxiliary control bit functions and flat circuits not shown.



Typical application of 488 DAP used as Power Supply Programmer.

2 Channel 488 DAP Series
Dimensional Drawings



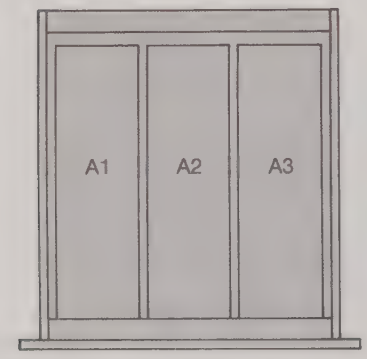
Wt.	lb.	kg.
	6.3	2.7

Note 1: All dimensions are in $\frac{\text{inches}}{(\text{mm})}$

Note 2: Two analog output cables (approx. 3 ft. long) are supplied, wired to mating output connectors.

RA500 Series
Power Assembly

Rack size for the RA 500 series is 5.25″ x 19″ x 22″. See page 57 for Rack details.
Each system comes completely assembled, wired, tested and ready for use in your application.



488 DAP Series Configuration
Maximum: 3 units

Sorensen Rack Number	Consists of	Location	Front Panel
SR 172117	1 ea. 488 DAP	A1	PA 501
SR 172143	2 ea. 488 DAP	A1, A3	PA 501
SR 172035	3 ea. 488 DAP	A1, A2, A3	PA 501

PA 501 is a full rack, blank filler panel for 488 DAP power assemblies.

SORENSEN
RAYTHEON
Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

Ordering Information

Domestic

Prices:
Consult current price list. The prices shown will be maintained for as long as possible, but please be advised that they are subject to change without notice.

Terms:
Net 30 days. FOB Manchester, New Hampshire.

Taxes:
The prices shown in the current Price List are standard. Add all applicable Federal, State and local taxes to the total price.

Quotations:
Inquiries are welcome concerning custom power supplies or minor modifications to our standard models. Furnish your local authorized Sorensen Sales Representative with complete specifications including quantity and desired delivery schedule.

Written quotations from Sorensen Company are valid for 30 days after date on quote form. Any other arrangement is only acceptable if in writing from an authorized Sorensen company official.

Source Inspection:
DD250 Forms are available. Ask Sorensen Sales Department for cost-per-destination charges, minimum cost for in-plant inspection and cost-per-shipment.

Shipment:
Normally all orders are shipped best available surface transportation. Air Freight or Air Express is available upon request.

Insurance is not provided unless requested and then it is invoiced as a separate item.

Delivery:
All models are considered standard stock based on the following schedule:

Modular P/S (Switching & Linear Series	Power Instruments	Normal Delivery*
1-20 units	1-10 units	From stock or up to 60 days.
21-60 units	11-40 units	90 days.
61+ units	41+ units	Consult factory.

*If prevailing conditions do not allow for immediate delivery on a specific model you will be notified promptly and given a shipping date.

Export Packing:
Heavy duty packing for Sea Freight shipment is available on request. Consult Sorensen Sales Department for information.

Testing:
Prior to being shipped from the factory, each Sorensen power supply is tested to assure that it performs within the specifications shown in our publications. All Sorensen power supplies are rated to accommodate normal component deviations.

Test Data:
Variables Test Data is available. Ask your Sorensen representative for details.

Repair Parts:
Sorensen maintains a full inventory of replacement parts for immediate shipment.

Customers may recalibrate, troubleshoot, or repair products as described in the instruction manual without voiding the warranty providing that professional instrument maintenance is performed, and such service is within the accepted norm and practices of the electronics industry. Sorensen Company will be the final arbiter of service problem disputes.

Warranty replacement parts are available to customers at not charge.

Limited Warranty:
Sorensen Company warrants all parts of each power supply to be of sound design, good materials and workmanship, and will repair or exchange any parts proven to be defective under normal use at no charge for a period of five years from the date of shipment. Please note that SLC-B series carries a warranty period of two years and Encapsulated Power Supplies carry a warranty period of three years.

Sorensen's liability under the terms of this warranty is limited to the satisfactory repair or replacement of defective products which have not been damaged through accident, abuse, misuse, or unauthorized repair. Sorensen shall in no case be liable for any special or consequential damages of any nature.

The unused portion of this warranty is fully transferable from the original purchaser if the Sorensen product is a component of the original purchaser's product or system.

Defects will be corrected by the factory or one of our authorized field service centers throughout the world. All products returned for repair must be shipped freight prepaid and be accompanied by a Return Material Authorization. Returned freight is shipped collect.

Return Shipments:
All Sorensen products require a Return Material Authorization Number prior to shipment back to the factory. This is required for equipment ordered in error or returned for service. Contact the factory for details and return authorization. Equipment returned for service should include a description of the problem encountered and return shipping instructions. Equipment ordered incorrectly is subject to a restocking charge. Exact charges will be determined when the return authorization is issued. Power assemblies, modified standard power supplied, non-standard, obsolete, and custom build equipment may not be returned for credit.

Federal Manufacturer's Identification No. 49958

All sales are subject to Raytheon Standard Terms and Conditions of Sale.

International

Prices:
Consult your local Sorensen authorized sales representative or stocking distributor for details concerning current prices, terms, taxes and discounts.

Quotations:
Inquiries are welcome concerning custom power supplies or minor modifications to our standard models. Furnish your local authorized Sorensen Sales Representative with complete specifications including quantity and desired delivery schedule.

Written quotations from Sorensen Company are valid for 30 days from date on quote form. Any other arrangement is only acceptable if in writing from an official authorized by Sorensen. Consult your Sorensen sales representative for local policy.

Shipment:
All orders originating in the United States are shipped Air Parcel Post unless you specify Air Freight, Air Express or Sea Freight. Insurance is not provided unless specifically requested and then it will be invoiced as a separate item.

Delivery:
Ask your local Sorensen sales representative to consult current price list for delivery data on Sorensen stock and limited production models. In the event a specific stock model is not immediately available, you will be notified promptly and given current shipping information.

Packing:
Items originating in the United States will, upon request, be provided with heavy duty packing for Sea Freight shipment. Consult your local Sorensen sales representative or authorized distributor for details.

Testing:
Prior to shipment from the factory each Sorensen power supply is tested to assure that it performs within the specifications printed in our publications. All Sorensen power supplies are rated to accommodate normal component deviations.

Test Data:
Variables Test Data can be made available. Ask your Sorensen representative for details.

Repair Parts:
Sorensen maintains a full inventory of replacement parts for immediate shipment.

Customers may recalibrate, troubleshoot, or repair products as described in the instruction manual without voiding the warranty providing that professional instrument maintenance is performed, and such service is within the accepted norm and practices of the electronics industry. Sorensen Company will be the final arbiter of service problem disputes

Warranty replacement parts are available to customers at no charge.

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Sorensen Catalog
Index

Pages

Sorensen Power Supply Engineering Information 1-15

Glossary of Terms 16

Warranty 17

MODULAR POWER SUPPLIES SECTION

SSD Series, High Power, Switching Power Supplies 18-21
STM Series, High Efficiency, Switching Power Supplies 22-25
SLC-B Series, Dual ac Input, Switching Power Supplies 26-29
SRX Series, High Power Density (2.47 W per cu. in.), Switching Power Supply 30-33
PTM Series, Single and Dual Output, Linear Power Supplies 34-37
QSA Series, Wide Range Adjustable Output, Linear Power Supplies 38-41
NM, KM, LM, PC Board Mounting, Miniature Encapsulated Linear Power Supplies 42-44
DM, DL Series, Chassis Mounting, Miniature Encapsulated Linear Power Supplies 45

POWER ASSEMBLIES SECTION

Features and Options 46-47
Selection Chart/Specifications, Single Output Series (SSD, STM, PTM, SLC-B) 48-49
Selection Chart/Specifications, Dual and Wide Range Adjustable Output (PTM and QSA) 50
Standard Rack Sizes 51
System 319, (3.5″ x 19″ x 19.4″) with various front panel options 52
System 519, (5.25″ x 19″ x 19.4″) with various front panel options 53-54
System 522, (5.25″ x 19″ x 22.4″) with various front panel options 55-56
Accessories 57
Rack Sub-Assemblies 58-59

POWER INSTRUMENTS SECTION

SRL Series, Medium Power, Variable Programming Laboratory and Industrial Power Supplies 60-63
DCRB Series, High Power, Single Phase Input Laboratory and Industrial Power Supplies 64-69
DCRA Series, High Power, Three Phase Input Laboratory and Industrial Power Supplies 70-76
DCRA Series, Optional Equipment (ST101, RP9 Kit, CSE Kit) 77
QRD Series, Bench, Lab, Test and System High Speed Programmable Power Supplies 78-80
QRD Series Rack Mounting Accessories and Optional Equipment 81
OVP Models Overvoltage Protectors for QSA and QRD Series 82-83
ACR Series, Solid State ac Line Regulator 84-87
ACR 500 Series, Rack Mounting Adapter, RP7 85

DIGITAL-TO-ANALOG PROGRAMMERS SECTION

488 DAP Series, Two Channel, Programmer, Interfaces to GPIB Bus per IEEE/488 88-91
RA500 Series Power Assembly (488 DAP) 91

General Ordering Information 92

Power Supply Information Request Form 94
Sales & Service Representatives 95-100

SORENSEN Sorensen Company, 676 Island Pond Road, Manchester, NH 03103 USA (603) 668-4500 TWX 710-220-1339

RAYTHEON

Power Supply Information Request

☐ I would like a quotation for _____ power assembly unit(s) based on the following data:

Power Supply Requirements for Rack

No. Outputs	Voltage	Current	(Check if required) OVP	Open Sense Protection	Metered*	Volt Adj.* Controls	Sorensen Model No.

*max. of 4 per rack

AC input voltage and frequency _____

Rack Size: ☐ 319 ☐ 519 ☐ 522 ☐ *other, see page 59 Front Panel Configuration: ☐ A ☐ B ☐ C ☐ D ☐ E
Option: ☐ Chassis Slide ☐ Line Cord

My power supply application is: _____

_____

☐ Immediate ☐ Within 6 months ☐ Undetermined _____

Please send additional information on model(s) _____

_____

Estimated number of power supplies purchased last year: ☐ none ☐ 1-50 ☐ 51-100 ☐ 101 +

I expect my power supply need to: ☐ decrease ☐ remain same ☐ increase

☐ Keep me on your mailing list. My major need is: ☐ linear ☐ switching ☐ lab ☐ OEM

Name _____ Title _____

Company _____ Division _____

Address _____

City _____ State/Country _____ Postal Code _____

Phone ( ) _____ Date _____

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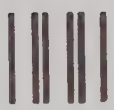
CUT, FOLD
FOLD



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3210 S. Norwood Ave., Suite C
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Beaverton, OR 97005
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Twx: 910-687-2267

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Maryland Heights, MO 63043
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Twx: 910-764-0840

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Twx: 910-743-4136

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Twx: 510-223-0417

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Elmont, NY 11003
Tel: 516-872-0800
Twx: 510-223-0417

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Binghamton, NY 13902
Tel: 607-772-6952

-Central-
*TAE-REP, Inc.
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Binghamton, NY 13902
Tel: 207-772-6952

-Western-
TAE-REP, Inc.
320 North Washington Street
Rochester, NY 14625
Tel: 716-586-8710

North Carolina
Currie, Peak & Frazier, Inc.
1212 Grove Street
P.O. Box 5588
Greensboro, NC 27403
Tel: 919-373-0380/273-3040

North Dakota
*Dytec/North, Inc.
1821 University Ave., Suite 173S
St. Paul, MN 55104
Tel: 612-645-5816
Twx: 910-563-3724

Ohio
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*Comtel Instruments Co.
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Cleveland, OH 44143
Tel: 216-442-8080
Tlx: 98-0444

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1717 Big Hill Road A6
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Tel: 513-298-7573

-Southern-
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5006 Cemetery Road
Hilliard, OH 43026
Tel: 614-876-8305

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Kemp Engineering Co., Inc.
3210 South Norwood, Suite C
Tulsa, OK 74135
Tel: 918-663-4501
Twx: 910-840-3585

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Northwest Test & Measurement
8196 S.W. Hall Blvd., Suite 217
Beaverton, OR 97005
Tel: 503-646-9966

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-Western-
Comtel Instruments Co.
9 Parkway Center
Pittsburgh, PA 15220
Tel: 412-922-5720

-Eastern-
Scientific Representatives, Inc.
304 Cooper Center
Pennsauken, NJ 08109
Tel: 609-662-5222
Twx: 710-892-1297

Puerto Rico
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Twx: 810-850-0106

Rhode Island
*Sorensen Company
676 Island Pond Road
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Tel: 603-668-4500
Twx: 710-220-1339

South Carolina
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Greensboro, NC 27403
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*Dytec/North, Inc.
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Suite 173S
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Currie, Peak & Frazier, Inc.
Castile Apartments P8
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-Northern-
*Kemp Engineering Co., Inc.
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Addison, TX 75001
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Twx: 910-860-5149

-Southern-
Kemp Engineering Co., Inc.
13728 FM-529
Houston, TX 77041
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Twx: 910-881-5532

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Albuquerque, NM 87108
Tel: 505-266-8616
Twx: 910-989-1639

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Trembly Associates
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Suite 11C
Salt Lake City, UT 84115
Tel: 801-486-5292

Vermont
*Sorensen Company
676 Island Pond Road
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Twx: 710-220-1339

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*Scientific Associates, Inc.
9512A Lee Highway
Fairfax, VA 22031
Tel: 703-385-0600
Twx: 710-883-0361

Washington
*Northwest Test & Measurement
4020 148th Ave. N.E., Suite F
Redmond, WA 98052
Tel: 206-881-8857
Tlx: 152199

West Virginia
-Central-
Comtel Instruments Co.
9 Parkway Center
Pittsburgh, PA 15220
Tel: 412-922-5720

-Eastern-
*Scientific Associations, Inc.
9512A Lee Highway
Fairfax, VA 22031
Tel: 703-385-0600
Twx: 710-833-0361

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-Western-
*Dytec/North, Inc.
1821 University Ave., Suite 173S
St. Paul, MN 55104
Tel: 612-645-5816
Twx: 910-563-3724

-Eastern-
*Dytec/Central, Inc.
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Arlington Heights, IL 60004
Tel: 312-394-3380
Twx: 910-687-2267

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Twx: 910-931-2553

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Ottawa, Ontario K1Z 5L3
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Allan Crawford Associates, Ltd.
7018 Cote DeLiesse
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Reforma 95-704
Mexico 4 DF
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Condell Park NSW 2200
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Yagoona NSW 2199
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Tlx: AA21168

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Antwerp Marine Radio Cy
Paardenmarkt 87
2000 Antwerpen
Tel: 32-31-337780/310487
Tlx: 31734 AMRC B

Denmark
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DK-1058 Copenhagen K
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Tlx: 15231 HEMPEL DK

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Tlx: 11625 NESCO NL

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137 Station Road
Otahuhu
Auckland
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Tlx: NZ21474

South Africa
Aerosignals M&M Pty Ltd.
P.O. Box 94
Johannesburg
Tel: 27-11-836-6828/9
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Raytheon Company
International Affairs
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Caracas, 1070
Tel: 239 12 11
Tlx: 25288 TELCON CA

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Eschenstrasse 2
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Arizona Electronic Standards Lab
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Phoenix, AZ 85015
602-264-9351

Arizona Electronic Standards Lab
1842 W. Grant Road — Suite 101
Tucson, AZ 85745
602-623-5779

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10601 Bloomfield Street
Los Alamitos, CA 90720
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R & R Instruments, Inc.
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Tel: 303-364-8325

Illinois
J.H. Metrology Co., Inc.
1801 Hicks Road Unit F
Rolling Meadows, IL 60008
Tel: 312-991-0290

Louisiana
Sea-Trac Marine
114 Hickory Avenue
New Orleans, Louisiana 70123
Tel: 504-737-0591

Maryland
Applied Metrology Inc.
10067 N. 2nd Street
Laurel, MD 20810
Tel: 301-953-1010

Michigan
Comtel Standards Laboratory
21223 Hilltop Street
P.O. Box 5034
Southfield, MI 48037
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Minnesota
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957 Winnetka Avenue, North
Minneapolis, MN 55427
Tel: 612-544-8916
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Industrial Service Laboratories
4354 Olive Street
St. Louis, MO 63108
MO Tel: 314-535-5760
For states contiguous to
Missouri: 1-800-325-8653

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676 Island Pond Road
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Fairfield, NJ 07006
Tel: 201-227-7720

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Tel: 505-842-1107

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Comtel Instrument Company
5827 Mayfield Road
Cleveland, OH 44124
Tel: 216-442-8080

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Westcom
5101 North Interstate Avenue
Portland, OR 97217
Tel: 503-283-0132

Texas
Certified Test Equipment Sales, Inc.
601 Easy Street
Garland, TX 75042
Tel: 214-494-3446

Washington
Radar Marine Electronics
16 Squalicum Mall
Bellingham, WA 98225
Tel: 206-733-2012

Canada

Brunelle Instrument Company
826 Belvedere Street
Sherbrook, P.Q., J1H 4B8
Tel: 819-569-1408
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Unit 14
Calgary, Alberta, Canada T2E 6Z5
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Tlx: AA 73648

England
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